

SECTION 31 20 00
EARTH MOVING**PART 1 - GENERAL****1.1 DESCRIPTION OF WORK**

A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for earthwork including, but not limited to, the following:

1. Site preparation.
2. Excavation.
3. Underpinning.
4. Filling and backfilling.
5. Grading.
6. Soil Disposal.
7. Clean Up.

1.2 DEFINITIONS

A. Unsuitable Materials:

1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 75 mm (3 inches); organic material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, as defined by ASTM D 698.
2. Existing Subgrade (Except Footing Subgrade): Same materials as 1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proofrolling, or similar methods.
3. Existing Subgrade (Footings Only): Same as paragraph 1, but no fill or backfill. If materials differ from design requirements, excavate to acceptable strata subject to Resident Engineer's approval.

B. Building Earthwork: Earthwork operations required in area enclosed by a line located 1500 mm (5 feet) outside of principal building perimeter. It also includes earthwork required for auxiliary structures and buildings.

C. Trench Earthwork: Trenchwork required for utility lines.

D. Site Earthwork: Earthwork operations required in area outside of a line located 1500 mm (5 feet) outside of principal building perimeter and within new construction area with exceptions noted above.

- E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1556, ASTM D2167, and ASTM D2922.
- F. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term "fill" means fill or backfill as appropriate.
- G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
- H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the Resident Engineer. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
- I. Authorized additional excavation: Removal of additional material authorized by the Resident Engineer based on the determination by the Government's soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- J. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
- K. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- M. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- N. Bedding course: Layer placed over the excavated sub-grade in a trench before laying pipe. Bedding course shall extend up to the springline of the pipe.
- O. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.
- P. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
- Q. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include but not be

limited to items like vehicles, equipment, appliances, building materials or remains thereof, tires, any solid or liquid chemicals or products stored or found in containers or spilled on the ground.

- R. Contaminated soils: Soil that contains contaminants as defined and determined by the Resident Engineer or the Government's testing agency.

1.3 RELATED WORK

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Safety requirements: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.
- C. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.
- E. Erosion Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, and Section 32 90 00, PLANTING.
- F. Site preparation: Section 02 41 00, DEMOLITION.
- G. Paving sub-grade requirements: Section 32 12 16, ASPHALT PAVING.

1.4 CLASSIFICATION OF EXCAVATION

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.
- B. Classified Excavation: Removal and disposal of all material except that material not defined as Rock.
- C. Rock Excavation:
1. Trenches and Pits: Removal and disposal of solid, homogenous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be excavated with a late-model, track-mounted hydraulic excavator; equipped with a 1050 mm (42 inch) wide, short-tip-radius rock bucket; rated at not less than 103 kW (138 hp) flywheel power with bucket-curling force of not less than 125 kN (28,090 lbf) and stick-crowd force of not less than 84.5 kN (19,000 lbf); measured according to SAE J-1179. Trenches in excess of 3000 mm (10 feet) wide and pits in excess of 9000 mm (30 feet) in either length or width are classified as open excavation.
 2. Open Excavation: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be dislodged and

- excavated with a late-model, track-mounted loader; rated at not less than 157 kW (210 hp) flywheel power and developing a minimum of 216 kN (48,510 lbf) breakout force; measured according to SAE J-732.
3. Other types of materials classified as rock are unstratified masses, conglomerated deposits and boulders of rock material exceeding 0.76 m³ (1 cubic yard) for open excavation, or 0.57 m³ (3/4 cubic yard) for footing and trench excavation that cannot be removed by rock excavating equipment equivalent to the above in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted.
 4. Blasting: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be removed with conventional methods may not be performed by blasting.
 5. Definitions of rock and guidelines for equipment are presented for general information purposes only. The Contractor is expected to use the information presented in the Geotechnical Engineering Report to evaluate the extent and competency of the rock and to determine both quantity estimations and removal equipment and efforts.

1.5 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION

- A. Measurement: Cross section and measure uncovered and separated materials, and compute quantities by Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. Do not measure quantities beyond the following limits:
 1. 600 mm (24 inches) from outside face of concrete work for which forms are required, except for footings.
 2. 300 mm (12 inches) from outside of perimeter of formed footings.
 3. 150 mm (6 inches) below bottom of pipe and not more than pipe diameter plus 600 mm (24 inches) in width for pipe trenches.
 4. From outside dimensions of concrete work for which no forms are required (trenches, conduits, and similar items not requiring forms).
- B. Payment: No separate payment shall be made for rock excavation quantities shown. Contract price and time will be adjusted for overruns or underruns in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

1.6 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Rock Excavation Report:

1. Certification of rock quantities excavated.
2. Excavation method.
3. Labor.
4. Equipment.
5. Land Surveyor's or Civil Engineer's name and official registration stamp.
6. Plot plan showing elevation.

C. Furnish to Resident Engineer:

1. Contactor shall furnish resumes with all personnel involved in the project including Project Manager, Superintendent, and on-site Engineer. Project Manager and Superintendent should have at least 3 years of experience on projects of similar size.
2. Soil samples.
 - a. Classification in accordance with ASTM D2487 for each on-site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
 - b. Laboratory compaction curve in accordance with ASTM D 698 for each on site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
 - c. Test reports for compliance with ASTM D 2940 requirements for subbase material.
 - d. Pre-excavation photographs and videotape in the vicinity of the existing structures to document existing site features, including surfaces finishes, cracks, or other structural blemishes that might be misconstrued as damage caused by earthwork operations.
 - e. The Contractor shall submit a scale plan daily that defines the location, limits, and depths of the area excavated.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
T99-01(2004).....Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop
T180-01(2004).....Moisture-Density Relations of Soils using a 4.54 kg (10 lb) Rammer and a 457 mm (18 inch) Drop
- C. American Society for Testing and Materials (ASTM):
D448-03a.....Standard Classification for Sizes of Aggregate for Road and Bridge Construction

- D698-00a1.....Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft³ (600 kN m/m³))
- D1556-00.....Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- D1557-02e1.....Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2700 kN m/m³))
- D2167-94 (2001).....Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- D2487-06.....Standard Classification of Soil for Engineering Purposes (Unified Soil Classification System)
- D2922-05.....Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- D2940-03.....Standard Specifications for Graded Aggregate Material for Bases or Subbases for Highways or Airports
- D. Society of Automotive Engineers (SAE):
- J732-92.....Specification Definitions - Loaders
- J1179-02.....Hydraulic Excavator and Backhoe Digging Forces

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.
- B. Fills: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups; free of rock or gravel larger than 75 mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off site sources having a minimum dry density of 1760 kg/m³ (110 pcf), a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.
- C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 37.5-mm (1 1/2-inch) sieve and not more than 12 percent passing a 75-µm (No. 200) sieve, per ASTM D2940;.
- D. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except

with 100 percent passing a 25 mm (1 inch) sieve and not more than 8 percent passing a 75- μ m (No. 200) sieve.

- E. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5 mm (1 1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.

F. Granular Fill:

1. Under concrete slab, crushed stone or gravel graded from 25 mm (1 inch) to 4.75 mm (No. 4), per ASTM D 2940.
2. Bedding for sanitary and storm sewer pipe, crushed stone or gravel graded from 13 mm (1/2 inch) to 4.75 mm (No 4), per ASTM D 2940.

PART 3 - EXECUTION

3.1 SITE PREPARATION

- A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions. Remove materials from Medical Center.
- B. Grubbing: Remove stumps and roots 75 mm (3 inch) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inch) diameter, and nonperishable solid objects a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left.
- C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by Resident Engineer. Remove materials from Medical Center. Box, and otherwise protect from damage, existing trees and shrubs which are not shown to be removed in construction area. Immediately repair damage to existing trees and shrubs by trimming, cleaning and painting damaged areas, including roots, in accordance with standard industry horticultural practice for the geographic area and plant species. Do not store building materials closer to trees and shrubs, that are to remain, than farthest extension of their limbs.
- D. Stripping Topsoil: Strip topsoil from within limits of earthwork operations as specified. Topsoil shall be a fertile, friable, natural topsoil of loamy character and characteristic of locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by Resident Engineer. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m³ (1/2 cubic foot) in volume, from soil as it is stockpiled. Retain topsoil on station. Remove

foreign materials larger than 50 mm (2 inches) in any dimension from topsoil used in final grading. Topsoil work, such as stripping, stockpiling, and similar topsoil work shall not, under any circumstances, be carried out when soil is wet so that the composition of the soil will be destroyed.

- E. Concrete Slabs and Paving: Score deeply or saw cut to insure a neat, straight cut, sections of existing concrete slabs and paving to be removed where excavation or trenching occurs. Extend pavement section to be removed a minimum of 300 mm (12 inches) on each side of widest part of trench excavation and insure final score lines are approximately parallel unless otherwise indicated. Remove material from Medical Center.
- F. Lines and Grades: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS, shall establish lines and grades.
1. Grades shall conform to elevations indicated on plans within the tolerances herein specified. Generally grades shall be established to provide a smooth surface, free from irregular surface changes. Grading shall comply with compaction requirements and grade cross sections, lines, and elevations indicated. Where spot grades are indicated the grade shall be established based on interpolation of the elevations between the spot grades while maintaining appropriate transition at structures and paving and uninterrupted drainage flow into inlets.
 2. Locations of existing and proposed elevations indicated on plans, except spot elevations, are from a site survey that measured spot elevations and subsequently generated existing contours and spot elevations. Proposed spot elevations and contour lines have been developed utilizing the existing conditions survey and developed contour lines and may be approximate. Contractor is responsible to notify Resident Engineer of any differences between existing elevations shown on plans and those encountered on site by Surveyor/Engineer described above. Notify Resident Engineer of any differences between existing or constructed grades, as compared to those shown on the plans.
 3. Subsequent to establishment of lines and grades, Contractor will be responsible for any additional cut and/or fill required to ensure that site is graded to conform to elevations indicated on plans.
 4. Finish grading is specified in Section 32 90 00, PLANTING.

- G. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations. No burning of materials is permitted onsite.

3.2 EXCAVATION

- A. Shoring, Sheet piling and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the Resident Engineer, banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities.
1. Design of the temporary support of excavation system is the responsibility of the Contractor.
 2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the Resident Engineer.
 3. Extend shoring and bracing to a minimum of 1500 mm (5 feet) below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
 4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall provide a concrete fill support in compliance with specifications Section 31 32 23 (Article 15.4.A), GROUT AND CONCRETE MIXES, under disturbed foundations, as directed by Resident Engineer, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by Resident Engineer.
- B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and undisturbed until approval of permanent work has been received from Resident Engineer. Approval by the Resident Engineer is also required before placement of the permanent work on all subgrades.
- C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the Resident Engineer.

D. Blasting: Blasting of materials classified as rock shall be permitted only when authorized by Resident Engineer. Contractor shall meet all federal, state, and local requirements.

1. Blasting shall be done with explosives of quantity and power, and fired in such sequence and locations as to not injure personnel, damage or crack rock against which concrete is to be placed, damage property, or damage existing work or other portions of new work. Contractor shall be responsible for damage caused by blasting operations.

E. Proofrolling:

1. After rough grade has been established in cut areas and prior to placement of fill in fill areas under building and pavements, proofroll exposed subgrade with a fully loaded dump truck to check for pockets of soft material.
2. Proofrolling shall consist of at least two complete passes with one pass being in a direction perpendicular to preceding one. Remove any areas that deflect, rut, or pump excessively during proofrolling, or that fail to consolidate after successive passes to suitable soils and replaced with compacted fill. Maintain subgrade until succeeding operation has been accomplished.

F. Building Earthwork:

1. Excavation shall be accomplished as required by drawings and specifications.
2. Excavate foundation excavations to solid undisturbed subgrade.
3. Remove loose or soft materials to a solid bottom.
4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete poured separately from the footings.
5. Do not tamp earth for backfilling in footing bottoms, except as specified.
6. Slope grades to direct water away from excavations and to prevent ponding.

G. Trench Earthwork:

1. Utility trenches (except sanitary and storm sewer):
 - a. Excavate to a width as necessary for sheeting and bracing and proper performance of the work.
 - b. Grade bottom of trenches with bell holes scooped out to provide a uniform bearing.
 - c. Support piping on undisturbed earth unless a mechanical support is shown.

- d. Length of open trench in advance of piping laying shall not be greater than is authorized by Resident Engineer.
- 2. Sanitary and storm sewer trenches:
 - a. Trench width below a point 150 mm (6 inches) above top of pipe shall be 600 mm (24 inches) maximum for pipe up to and including 300 mm (12 inches) diameter, and four-thirds diameter of pipe plus 200 mm (8 inches) for pipe larger than 300 mm (12 inches). Width of trench above that level shall be as necessary for sheeting and bracing and proper performance of the work.
 - b. Bed bottom quadrant of pipe on undisturbed soil or granular fill.
 - 1) Undisturbed: Bell holes shall be no larger than necessary for jointing. Backfill up to a point 300 mm (12 inches) above top of pipe shall be clean earth placed and tamped by hand.
 - 2) Granular Fill: Depth of fill shall be a minimum of 75 mm (3 inches) plus one sixth of pipe diameter below pipe to 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.
 - c. Place and compact as specified remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.
 - d. Use granular fill for bedding where rock or rocky materials are excavated.
- H. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation. Excavation shall be accomplished as required by drawings and specifications. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm (1 inch). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements, and for inspections. Remove subgrade materials that are determined by Resident Engineer as unsuitable, and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the contractor shall obtain samples of the material, under the direction of the Resident Engineer, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. When unsuitable material is encountered and removed, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and

CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on volume in cut section only.

1. Site Grading:

- a. Provide a smooth transition between adjacent existing grades and new grades.
- b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed. Finish subgrades to required elevations within the following tolerances:
 - 1) Lawn or Unpaved Areas: Plus or minus 25 mm (1 inch).
 - 2) Walks: Plus or minus 25 mm (1 inch).
 - 3) Pavements: Plus or minus 13 mm (1 inch).
- d. Grading Inside Building Lines: Finish subgrade to a tolerance of 13 mm (1/2 inch) when tested with a 3000 mm (10 foot) straightedge.

3.3 UNDERPINNING

- A. Design of the underpinning system is the responsibility of the Contractor and is subject to review and approval by the Resident Engineer. Underpinning of existing building foundations, as indicated on structural drawings, or where excavation undermines existing foundations, shall be accomplished in the following manner:
1. Make general excavation for new construction, where new foundations are to be below existing foundations, to elevation of new foundations (or sized stone subbase), maintaining a 45 degree sloped berm.
 2. For underpinning pits, underpin existing wall foundations by excavating 1200 mm (4 feet) wide pits to depth shown on drawings skipping 3 sections at any one time so as to maintain support for wall at all times.
 3. Underpin intervening sections one at a time; no adjacent sections shall be underpinned until concrete in adjacent sections shall have reached 20 MPa (2500 psi) strength and have been dry packed with non-shrink grout to obtain positive bearing. Sheet and brace underpinning pits if soil will not stand on a vertical cut during this operation, or as required for safety of workmen. Repack any voids behind sheeting to prevent sloughing which could cause settlement of existing foundations. Contractor performing this portion of work shall have been prequalified by Resident Engineer as having previously performed successfully this type of work or will demonstrate his capability for successfully performing this work. It

shall be sole responsibility of the Contractor to guard against objectionable movement or settlement and to preserve integrity of existing structures.

4. The tip elevation of the underpinning pits shall be a minimum of 900 mm (3 feet) below the adjacent excavation elevation.
5. Subgrades at the tip of the underpinning pit shall be clean, dry, and free of debris and shall be observed by the Resident Engineer prior to concrete placement.
6. Concrete shall not be free fall greater than 3000 mm (10 feet) into the pit.

3.4 FILLING AND BACKFILLING

- A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation. For fill and backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Borrow will be supplied at no additional cost to the Government. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, foundation drainage, and pipes coming in contact with backfill have been installed and work inspected and approved by Resident Engineer.
- B. Placing: Place materials in horizontal layers not exceeding 200 mm (8 inches) in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm (4 inches) in loose depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen, or contain frost.
- C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors, or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without prior approval of Resident Engineer. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Compact soil to not less than the following percentages of maximum dry density, according to ASTM D698 or ASTM D1557 as specified below:
 1. Fills, Embankments, and Backfill

- a. Under proposed structures, building slabs, steps, and paved areas, scarify and recompact top 300 mm (12 inches) of existing subgrade and each layer of backfill or fill material in accordance with ASTM D698 100 percent.
 - b. Curbs, curbs and gutters, ASTM D698 95 percent.
 - c. Under Sidewalks, scarify and recompact top 150 mm (6 inches) below subgrade and compact each layer of backfill or fill material in accordance with ASTM D698 95 percent.
 - d. Landscaped areas, top 400 mm (16 inches), ASTM D698 90 percent.
 - e. Landscaped areas, below 400 mm (16 inches) of finished grade, ASTM D698 95 percent.
2. Natural Ground (Cut or Existing)
- a. Under building slabs, steps and paved areas, top 150 mm (6 inches), ASTM D698 95 percent.
 - b. Curbs, curbs and gutters, top 150 mm (6 inches), ASTM D698 95 percent.
 - c. Under sidewalks, top 150 mm (6 inches), ASTM D698 95 percent.

3.5 GRADING

- A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.
- B. Cut rough or sloping rock to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside building away from building walls for a minimum distance of 1800 mm (6 feet).
- D. Finish grade earth floors in pipe basements as shown to a level, uniform slope and leave clean.
- E. Finished grade shall be at least 150 mm (6 inches) below bottom line of window or other building wall openings unless greater depth is shown.
- F. Place crushed stone or gravel fill under concrete slabs on grade, tamped, and leveled. Thickness of fill shall be 150 mm (6 inches) unless otherwise shown.
- G. Finish subgrade in a condition acceptable to Resident Engineer at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further

construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.

- H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.
- B. Disposal: Transport surplus satisfactory soil to designated storage areas on Medical Center property. Stockpile or spread soil as directed by Resident Engineer.
1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.
- C. Place excess excavated materials suitable for fill and/or backfill on site where directed.
- D. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.
- E. Segregate all excavated contaminated soil designated by the Resident Engineer from all other excavated soils, and stockpile on site on two 0.15 mm (6 mil) polyethylene sheets with a polyethylene cover. A designated area shall be selected for this purpose. Dispose of excavated contaminated material in accordance with State and Local requirements.

3.7 CLEAN UP

- A. Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from Medical Center Property.

----- E N D -----

SECTION 31 32 23
GROUT STABILIZATION OF ABANDONED UNDERGROUND MINE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the requirements for furnishing all equipment, materials, labor and techniques for stabilizing abandoned underground coal mine workings by grouting as shown on the drawings or as directed. The project site is located on the Veterans Administration Hospital Grounds, Oakland Campus in Pittsburgh Pennsylvania. The site is undermined by abandoned mine workings in the Pittsburgh Coal seam at a depth of approximately 30.5m (100 feet) from the existing ground surface. The purpose of the activities covered by this section of the specifications is to stabilize the mine workings below the proposed Research Office Building and thereby reduce potential for ground movements resulting from mine subsidence. This purpose is to be achieved by filling with concrete or grout, the mine voids, fractures, and interstices from the base of the mine to the ground surface within the area designated on the drawings.
- B. No test borings have been drilled to mine level at this building site. The accuracy of the relationship of the mine workings to the ground surface is unknown. The bidder may, at the bidder's expense, make additional explorations deemed necessary in the planning for construction, after coordinating with the Government. The test boring log sheets for the geotechnical investigation at the Research Office Building are for information only and are presented elsewhere.

1.2 DEFINITIONS

- A. Zone: A zone is the horizontal area influenced by injection into a hole.
- B. Void: A void is any subsurface opening resulting from the removal of coal from the coal seam.
- C. Gob: Gob is a mixture of materials found at mine level that consists of roof shales and other rock materials that have fallen or have been placed in a void during mining.

- D. Coal Pillar: Coal pillar is an unmined block of coal remaining in the coal seam.
- E. Stage: A stage is a vertical subsurface injection interval which may include all or part of the drill hole length.
- F. Gravity Injection: Gravity injection is the method used to place grout or concrete into the injection hole without pressure packers being used. The necessary materials are placed through a pipe at the specified interval of depth under the action of gravity (gravity flow). Pumping will be required to place concrete and grout at mine level to overcome friction in the injection hoses and pipes.
- G. Overburden: Overburden includes soil, rock, and all other materials.
- H. Take: Take is the volume of material injected into a specified interval of an injection hole.
- I. Mine Workings: The vertical interval which corresponds to the mined portion of the coal. This interval starts at the base of the coal and extends to the mine roof.
- J. Closure: A closure (split spacing) method for secondary injection used in areas determined by the Professional. Closure holes will normally be located midway between three or four holes injected previously.

1.3 RELATED WORK

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Earth excavation: Section 31 20 00, EARTH MOVING.
- C. Concrete, including materials and mixes: Section 03 30 00, CAST-IN-PLACE CONCRETE.

1.4 CONTRACT BASIS

- A. Previous subsurface stabilization grouting has occurred for construction of the original Veterans Administration building and for the later Clinical, Educational, Outpatient, and Parking Garage additions, as well as for the Mental Health Facility.

Previously placed grout may be encountered in this exploration drilling and grouting program.

1.5 MEASUREMENT AND PAYMENT FOR MINE GROUTING

- A. The contract unit prices for the various items of work and materials as described in this Section and shall constitute full compensation for furnishing all equipment, material, labor and supervision at the job site, and all incidental work in accordance with these Specifications. The estimated numbers of units shown on the Contractor's Bid Sheet (Appendix A) are for bidding purposes only. The estimated drilling quantities are based on existing ground surface elevations. Grout estimates are based upon limited information for the mine conditions. The actual quantities may vary substantially from the estimates shown. Final compensation will be based on the actual quantities used and the unit prices contained in the bid, with no changes in unit prices regardless of the final quantities used.

1.6 GOVERNMENT AND PROFESSIONAL

- A. The Government is the Department of Veteran Affairs - United States of America. The resident engineer, as employed by the government, will monitor the work. The Professional is the organization contracted by the resident engineer to assist with the monitoring of the work covered by this section of the specification.

1.7 SITE HEALTH AND SAFETY

- A. The Contractor is responsible for health and safety with respect to all site activities related to the grout stabilization work.
- B. Follow generally accepted drilling practices and be responsible for all matters in performing the work, dealing with safety of the general public, employees, and employees of subcontractors which may perform work. This requirement will apply continuously regardless of time and place, and will in no way be altered because the Professional gives general directions as to the locations where drilling and grouting should occur.
- C. Comply at all times with applicable Federal, State and local laws, provisions, and policies governing safety and health, including the Federal Construction Safety Act (Public Law 91-54), Federal Register Chapter XVII, Part 1926 of Title 29 Code of Federal Regulations, Occupational Safety and Health Regulations for Construction, and subsequent publications updating these regulations. The minimum required clearance between overhead power lines and any part of the drill rig, including any drill steel, is 4570mm (15 feet), unless greater minimum clearances are required for safety.

- D. Be aware that underground utilities exist beneath the site.
- E. Take appropriate measures to avoid any underground utilities that have not been removed prior to the present grouting operation. Refer also to PART 3.6 of these specifications.

1.8 STANDARDS

- A. All referenced standards shall be the current standards at the time of construction.

1.9 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - 1. C150.....Standard Specification for Portland Cement
 - 2. C33.....Standard Specification for Concrete Aggregates
 - 3. C94.....Standard Specification for Ready-Mixed Concrete
 - 4. C494.....Standard Specification for Chemical Admixtures for Concrete
 - 5. C939.....Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
 - 6. C618.....Standard Specification for Coal Flyash and Raw or Calcined Natural Pozzolan For Use in Concrete
 - 7. C39.....Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - 8. C31.....Standard Practice for Making and Curing Concrete Test Specimens in the Field
 - 9. C109.....Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
 - 10. C143.....Standard Test Method for Slump of Hydraulic-Cement Concrete

PART 2 - PRODUCTS

2.1 FORMS (NOT USED)

2.2 MATERIALS

- A. Water: The water used in grout and concrete shall be clean and free from injurious amounts of sewage, oil, acid, alkali, salts, organic matter or any other foreign solids, and shall be furnished by the Contractor. The water used shall meet the requirements of ASTM C 94. Whenever the outside air temperature is below 20° F, the Contractor shall heat all water for mixing, cleaning or flushing. The final mix temperature shall range from 40° F to 80° F, with the water temperature not exceeding 140° F at the time of mixing.
- B. Cement: Cement used in grout or concrete shall conform to the requirements of ASTM C 150, "Portland Cement", Type II. The Contractor shall furnish and store cement so that it will not deteriorate from moisture, weather or other causes. Cement which has been in storage more than two months shall not be used for concrete or grout. The use of bulk cement will be permitted provided the Contractor provides methods of handling, transporting, storage and measuring that are satisfactory to the Professional. If sacked cement is used on the project, it shall be used in the chronological order in which it is delivered on the job to prevent undue aging after delivery. Store each shipment of cement so that it may readily be distinguished from other shipments. Use cement free from lumps due to warehouse set. No additional payment will be made for screening or for old cement which must be wasted.
- C. Fine Aggregate: Fine Aggregate shall be sand-sized and consist of hard, dense, durable rock fragments and shall meet all requirements of ASTM C 33.
- D. Coarse Aggregate: Coarse aggregate shall consist of hard, dense, durable rock fragments and shall meet the gradation requirements of AASHTO Number 7 (¾ inch to #8) or AASHTO #8 (½ inch to #16) and conform to all requirements of ASTM C 33.
- E. Fly Ash: Fly ash supplied shall meet the requirements of ASTM C 618, Type F fly ash, resulting from combustion of pulverized coal supplied and handled by the Contractor. The Type F fly ash can have a maximum Loss on Ignition (LOI) of up to 12 percent if laboratory strength testing is made available in advance showing adequate strength. The fly ash for this project shall come from

one source, subject to the approval of the Professional. The Contractor shall provide test results that show that the fly ash conforms to the above requirements.

- F. Accelerator: The use of an early set accelerator shall be added to the mixes when directed by the Professional. All accelerator products shall conform to ASTM C 494.
- G. Optional - High Range Water Reducer: The use of a water reducer may be added to the concrete mix only with the approval of the Professional. All water reducing products shall conform to ASTM C 494. There will be no additional payment for the use of water reducers.
- H. Optional - Set Retarder: The use of a set retarder may be added to the mixes only with the approval of the Professional. All set retarding products shall conform to ASTM C 494. There will be no additional payment for the use of set retarders.

2.3 GROUT AND CONCRETE MIXES

- A. Grout Mix: The water-cement-fly ash ratio of the grout mix shall be determined by the Contractor. The grout must be flowable and shall have a minimum unconfined compressive strength of 200 psi at 3 days cure. The Contractor shall be responsible for insuring that the grout mix can be pumped through the injection pipe he intends to utilize for the work. The grout placed shall meet or exceed the required minimum unconfined compressive strength and shall not exceed the water/cement ratio of the design mix. The grout shall have a flow cone value ranging from 30 to 60 seconds as determined by ASTM C 939.
- B. Concrete Mix: Concrete shall be composed of a mixture of coarse aggregate, fine aggregate, cement, fly ash and water. Low slump concrete shall have a mix proportioned for a two- to four-inch slump. High slump concrete shall be proportioned for a four- to eight-inch slump. The Contractor shall be responsible for insuring that the design mix for low and high slump concrete can be pumped through the injection pipes that he intends to use for the work. All concrete placed shall have a minimum unconfined compressive strength of 200 psi after 3 days of curing, and the water/cement ratios shall not exceed those of the design mix for each design slump.
- C. Mix Designs: All concrete and grout mix designs to be used by the Contractor will be subject to review and approval of the Professional. The Contractor shall submit to the Professional the proposed mix designs along with sufficient test data using

the proposed sources of mix components to verify strength parameters prior to the initiation of injection operations. This design mix testing shall include the corresponding slump or fluidity test results for the design mixes. If during injection operations either the testing indicates that required strengths are not being achieved or the design mix proportions are not being achieved, then the Contractor shall modify the mix proportions to achieve satisfactory mix proportions and strengths.

- D. All unconfined compressive strength requirements of this Specification are based on testing according to ASTM C 39 of cylindrical samples prepared according to ASTM C 31. If the Contractor desires to mold and test cube samples of grout according to ASTM C 109 to assist in quality control during injection, he must also present the results of unconfined compressive strengths of cube samples of the design mixes prior to the initiation of grouting and concreting operations. These test results will be used by the Professional to determine if and how much the design strength measured for cube samples must be increased in order to determine that the specified unconfined compressive strength based on cylindrical samples is being achieved.

PART 3 - EXECUTION

3.1 GENERAL

- A. The work to be performed by the Contractor consists of furnishing all supervision, labor, plant, power and equipment, and performing all operations in connection with the stabilization program including, but not limited to providing access to the holes, the drilling and casing of holes; securing a sufficient potable water supply for construction activities; and providing, handling, transporting, storing, mixing, and injecting the materials. The work includes downhole video explorations and secondary injection holes. The work also consists of proper handling and disposal of drill cuttings, wastewater and waste materials, and of the cleanup and restoration of the area upon completion of the work and all other such operations as are incidental to the program as specified herein. The purchase and delivery of materials to the site, and their storage, will be the responsibility of the Contractor unless otherwise specified.

3.2 SUPERVISION

- A. Unless the Contractor is an individual and gives his personal supervision to the work, the Contractor shall provide a competent

superintendent, satisfactory to the Government, on the work site at all times during working hours with full authority to act for the Contractor.

3.3 ENVIRONMENTAL CONTROL

- A. Drill holes will intercept deep, abandoned mine workings and may encounter methane gas during the drilling and grouting process. A methane and oxygen monitor shall be provided by the Contractor. The monitors shall be operating at the location of each boring drilled to a mined underground coal seam. Monitors shall be maintained in operating condition, including calibration, for the life of the project. The monitors shall be available to the Professional for checking the drill holes and any previously drilled holes on the project. Repair or replacement of monitors shall be made within 24 hours of any malfunction. Drilling holes in deep mined areas will not be permitted if the monitor is not present as specified.
- B. If a methane concentration above one (1) percent is detected, the Contractor shall install suitable standpipes, flame arrestors, and other required accessories to prevent explosions. If a methane concentration above five (5) percent is detected and/or if the oxygen percentage falls below 19.5 percent, work shall be stopped until the methane level decreases below five (5) percent and/or the oxygen percentage increases above 19.5 percent.
- C. The Contractor shall conduct all work in such a manner that the amount of dust, erosion, clogging of existing drains and damage to local flora and fauna is minimized. Exterior equipment for the existing adjacent buildings and facilities may need to be cleared of dust during the drilling and grouting work. General site cleanup shall be performed upon the completion of work or on a daily basis as determined by the Government.

3.4 DRAWINGS

- D. The Mine Grouting Plan in the List of Drawings is part of this Specification. Other contract drawings (separate from this package) should be reviewed for further information regarding site conditions. They are:
 - 1) Site Existing Conditions Plan
 - 2) Site Demolition Plan

3.5 INTERPRETATIONS

- A. The Contractor shall make his own interpretations of the surface and subsurface conditions, which may affect his methods or costs of execution of the work. The Contractor herein agrees to make no claim for damages or extra compensation should the Contractor find conditions during the progress of the work different from those the Contractor calculated or anticipated.

3.6 UTILITIES AND OTHER OBSTRUCTIONS

- A. Utility locations, where indicated on the Drawings, are approximate and are based on available data obtained from the various utility companies contacted and the Government. This information shall be verified by the Contractor prior to the initiation of work. It shall be the sole responsibility of the Contractor to locate and avoid all underground and overhead utilities, facilities and other structures and obstructions. For that purpose, the Contractor shall employ all necessary precautions and methods to insure avoidance of and prevention of damage to such underground and above ground utilities and facilities, including the use of inclined injection holes, where necessary, to intercept target locations at mine level from offset points at ground surface.
- B. In the event such damage does occur, the Contractor shall notify the affected utility Government and the Project Government immediately. The Contractor shall make or have made all necessary repairs and bear the expense of repairs for the damage thereof and any resulting damage caused thereby.

3.7 EQUIPMENT RESPONSIBILITY

- A. All equipment furnished shall be in satisfactory operating condition and capable of safely and efficiently performing the work required. Qualified operating personnel shall be provided by the Contractor for the operation of this equipment. The Contractor shall furnish and install, at the Contractor's own expense, all fuel, oil, grease, cable, repair parts, tools and all other miscellaneous supplies and parts necessary for the efficient operation of each unit. Repairs and replacements shall be made by the Contractor at the Contractor's own expense. Repairs and replacements shall be made when needed to maintain the project schedule and/or within 48 hours of written notification from the Government.

3.8 TRAFFIC MAINTENANCE

- A. The Contractor shall contact the appropriate officials and the Resident engineer regarding the requirements for the maintenance and protection of traffic along all affected roadways for the duration of the contract. The maintenance of traffic, including the costs of any materials, labor, fees, permits, etc., shall be the sole responsibility of the Contractor. All roadways shall be maintained in clean condition.

3.9 LIMITING ACCESS

- A. The Contractor shall be responsible for erecting any temporary barriers and warning signs necessary to limit access to the construction area.

3.10 DAMAGES

- A. The Contractor shall be responsible for any and all damages arising from the Contractor's activities.

3.11 PERMITS AND LICENSES

- A. The Contractor must contact the proper federal, state and local governmental authorities and the University of Pittsburgh to determine the permits and licenses required for work on this project. It is the Contractor's responsibility to obtain all necessary permits and licenses required for the project and to pay any fees necessary for obtaining same.

3.12 SURVEY CONTROL POINTS AND LAYOUT

- A. SCOPE
 - 1. This work consists of furnishing, placing and maintaining layout stakes or marks necessary for the proper performance of work under this contract
- B. PROCEDURE:
 - 1. The Contractor shall locate and identify all injection holes, as shown on Drawing "Mine Grouting Plan". Field reference control points will be provided by the Government or the Resident engineer. The elevations of the tops of all holes shall be

determined by the Contractor to the nearest 150MM (6 inches) with reference to a benchmark established by the Government or the Resident engineer. The top (ground surface location) of the hole shall be offset where necessary to avoid any underground utilities that were not removed or relocated by others prior to construction.

2. The Contractor shall locate each hole within 150mm (6 inches) of the planned location. Each injection hole shall be marked with a 2 50mm (2-inch) square by 150mm (6-inch) long oak hub driven flush with the ground surface, or on existing pavement or concrete shall be indicated with chisel marks, paint, and/or offset stakes. A witness stake or paint markings bearing the hole number and ground surface elevation shall be placed at each hole location. Alternately, the Contractor shall provide the Resident engineer with tabular summaries of the ground surface elevations at each hole location, and shall mark a sufficient number of holes (acceptable to the Resident engineer) to identify all hole designations. The Contractor shall replace any stakes or markings destroyed prior to the completion of injection operations in any hole.
3. The Contractor's surveys shall be performed by a surveyor licensed or registered in the Commonwealth of Pennsylvania unless approved otherwise by the Resident engineer.
4. All of the Contractor's survey procedures shall be subject to review and approval by the Resident engineer.

C. METHOD OF PAYMENT:

1. Furnishing, setting, maintaining, and resetting the stakes or pavement marks, when necessary, and furnishing all Professionalizing personnel, equipment, materials, and all incidentals thereto, shall be considered incidental to the other work activities and provided at no additional cost to the project.

3.13 MOBILIZATION AND DEMOBILIZATION

A. SCOPE

1. This work consists of delivering and assembling all plant and equipment at the site prior to initiating drilling and injection procedures and removal of plant and equipment and restoration and cleanup of the site when the work has been completed.

B. PROCEDURE

1. Upon receipt of notice to proceed, the Contractor shall initiate and complete measures necessary to commence drilling and injection procedures. Upon the completion of the work and with the prior approval of the Resident engineer, the Contractor shall remove from the site all his plant, equipment, and materials and he shall cleanup and restore the site to the satisfaction of the Government.

C. METHOD OF MEASUREMENT

1. Mobilization and demobilization of all labor, materials, and equipment as described in the preceding sections shall be measured as a unit.

D. BASIS OF PAYMENT

1. This item will be paid at the contract lump sum price for "Mobilization and Demobilization." This item shall not exceed fifteen percent of the Total Estimated Drilling Cost as shown on the Contractor's Bid Sheet. Partial payments for Mobilization and Demobilization will be 50 percent after full mobilization and 50 percent after full and acceptable demobilization.

3.14 SITE PREPARATION

A. SCOPE

1. Work in this Section shall be performed in accordance with the Drawings and as specified herein. The work shall include, but not necessarily be limited to, erosion and sedimentation control, temporary construction roads, and clearing and grubbing, if required. The work includes the control, collection and disposition of drilling water, mine water, groundwater, grout and concrete that may surface as a result of the drilling and grouting programs. It may include special site protection or restoration measures, if required.
2. The demolition of Buildings 2, 3, 4 and 28, by others, will precede the grout stabilization work. Possible foundation materials and other demolition debris may be present in these areas. The contractor is responsible for determining the associated drilling conditions.

B. PROCEDURES

1. The Contractor shall keep construction runoff from the existing roadways and adjacent properties off the project site. Construction runoff includes, but not limited to, drilling fluids, mine water, groundwater, grout or concrete. METHODS OF MEASUREMENT
2. Site preparation, including erosion and sedimentation control, temporary road construction, construction runoff, and clearing and grubbing, when completed and accepted by the Resident engineer, will be measured as a unit.

C. BASIS OF PAYMENT

1. This item will be paid at the contract lump sum price for Part_Artical, "SITE PREPARATION" as shown on the Contractor's Bid Sheet. Half of this item will be paid midway through the project and the other half at demobilization.

3.15 INJECTION HOLE DRILLING

A. SCOPE

1. This work consists of drilling injection holes from the ground surface to below the base of the mined coal seam and installing casing as directed by these Specifications. The anticipated sequence is to drill all injection holes prior to grouting, emplace low slump concrete through the perimeter injection holes and then emplace flowable grout through interior injection holes. Secondary injection holes may be added by the Professional for confirmation of grout take and filling of additional borings or voids. Observations of encountered voids and conditions at mine level may be accomplished using a borehole video camera service when requested by the Professional.

B. EQUIPMENT

1. Standard rotary or downhole percussion type drilling equipment can be used. The drilling equipment must be capable of drilling the injection holes as indicated on the Mine Grouting Plan to the required diameter and depth. The drilling equipment must be equipped with dust control devices and pressure gauges which indicate the downhole drilling pressure. A minimum of two (2) drilling rigs is required.

C. PROCEDURES

1. All boreholes drilled for injection purposes shall be drilled to a point two feet below the base of the mined seam and shall have a diameter of sufficient size to permit the installation and removal of the required casing and supply pipe and other materials. The boreholes shall have a nominal diameter in rock of no less than 150MM (six-inches) for vertical and inclined holes. The locations indicated on the Drawing may be modified by the Professional as required by the particular conditions of a certain area. Drilling shall be performed in such a manner as to minimize mine-roof collapse, such as by reducing down pressure directly above the mine. The Contractor will be responsible for drilling holes as needed to reach the desired plan location at mine level as shown by the injection hole location plan. The holes shall be drilled with bits and stabilizers or collars (as required) to provide full-diameter, straight holes. Vertical holes shall have a maximum deviation from the vertical of two percent of the hole length. Inclined holes shall be started within 2 degrees of the specified angle. Certain locations where inclined holes are required are shown on The Mine Grouting Plan, but do not represent all locations where inclined holes may be needed. The Contractor must secure permission from adjacent property owners to drill vertically to mine level target locations that are beyond the property limits. If entry is denied, the use of inclined holes will be necessary. Anticipate inclined holes to avoid locations where traffic must be maintained, where space is limited, and where obstructions and utilizes are present. The use of inclined holes may be necessary to avoid underground utilities that have not been relocated prior to the present grouting operation. Anticipate no more than 30 percent of the total boring footage will be inclined borings.
2. Special provisions to avoid entities, such as existing structures and utilities, shall be approved by the Professional prior to the Contractor drilling the particular boreholes.
3. The Contractor shall be responsible for removing and replacing at his own expense any fences, trees, shrubs, lawns, and the like, which are damaged as a result of the drilling and injection work. The Contractor shall, at his own expense, also correct any damage done to sidewalks, driveways, pavements, patios, and other features due to drilling and injection work.
4. Water encountered in the drilling process and carried to the surface with cuttings shall be contained and filtered by the use of straw bales or silt fence. Straw bales or silt fence shall be paid under Part 3.14, "SITE PREPARATION" Article C. Cuttings and dust sludge shall be cleaned from the hole area after drilling is

completed and prior to injection into the hole. Water encountered in the grouting process and carried to the surface will be controlled, collected and discharged into appropriate storm or other drainage systems. Water discharged from the work area shall meet all applicable Federal, State and local effluent limitations.

5. It shall be the responsibility of the Contractor to protect all drilled and cleaned out holes from debris until the completion of the work at the hole. Any required cleaning of the hole after initial drilling and cleaning shall be at the Contractor's expense.
6. Each hole drilled shall be capped and otherwise protected from entry by foot traffic and caving and/or becoming clogged or obstructed. Injection holes through soil shall be cased to the top of rock. All pipe fittings required for casing holes shall be furnished, handled and installed by the Contractor. The casing must be strong enough to maintain an open hole. Metal or plastic casing may be used as approved by the Professional and shall extend a minimum of one (1) foot above the ground surface, unless otherwise approved. Casings in overburden above the top of rock shall be of sufficient inside diameter to permit drilling the required diameter hole in rock. Casing to be left in any paved area shall be steel cut flush to pavement level and closed with a steel cap. Casings shall be left in the hole until the completion of injection of that hole. All metal casing shall be removed completely, and plastic casing shall be removed to a minimum of one-foot below finished subgrade. The Government will delete from payment to the Contractor all costs associated with removal of unauthorized casing left in place by the Contractor.
7. The safety of the motoring public and pedestrians shall be kept in mind at all time if casings are located within the streets and sidewalks.

D. RECORDS OF BORINGS

1. Drilling records will be developed by the Professional to document the types of overburden and rock encountered, the depth of changes in overburden above top of rock and rock types, locations of voids, fractures, and water bearing zones. In every hole, special attention shall be given to the conditions at mine level (example: presence of coal, gob, roof falls, voids, mud and water), and location of abnormal loss or gain of drill water or air. The Professional shall note on the drilling record which holes, if any, are interconnected as evidenced by dust or water discharge from hole(s) other than the hole being drilled. The fact that the Professional will be present and keeping a record

of the drilling shall not relieve the Contractor from the requirement of keeping his own accurate log as described above.

2. A copy of the Contractor's drilling records (logs) shall be provided to the Professional within one day of completion of the hole and prior to the injection of material.

E. DIRECTIVES

1. Depending upon the condition at the time of construction, the Professional reserves the right to:
 - a. Specify the sequence of drilling;
 - b. Terminate the drilling of any of the holes at any depth;
 - c. Order the drilling of holes in addition to those specified herein or delete the drilling of holes specified herein;
 - d. Change the proposed locations of any of the holes; and
 - e. Add additional holes for grouting and/or confirmation

F. METHOD OF MEASUREMENT

1. Drilling and Casing Injection Holes Through Soil: Measurement for payment for both vertical and inclined injection holes in overburden above top of rock will be made in lineal feet from the ground surface to the actual depth drilled and cased along the axis of the hole and shall include the cost of furnishing all labor, materials, pipe, casing, tools and equipment required for drilling and casing the holes, removing all materials from the casing and maintaining the holes open and clean until no longer required, removing the casing from the hole, and all incidental work connected therewith.
2. Drilling Injection Holes in Rock: Measurement for payment of drilling of both vertical and inclined injection holes in rock will be made in lineal feet from the bottom of casing to the actual depth drilled along the axis of the hole. This shall include the cost of furnishing all labor, materials, tools and equipment required for drilling the holes, maintaining holes free from obstruction until injection is completed, and all incidental work connected therewith.

G. BASIS OF PAYMENT

1. Drilling and Casing Vertical Injection Holes Through Overburden Top of Rock: Payment will be made at the contract unit price per lineal foot.
2. Drilling and Casing Inclined Injection Holes Through Overburden above Top of Rock: Payment will be made at the contract unit price per lineal foot.
3. Drilling Vertical Injection Holes in Rock: Payment will be made at the contract unit price per lineal foot.
4. Drilling Inclined Injection Holes in Rock: Payment will be made at the contract unit price per lineal foot.

3.16 SUBSURFACE INJECTION

A. SCOPE

1. This work consists of purchasing, handling and delivering to the site all required materials for injection and injecting the materials as directed by these specifications.

B. EQUIPMENT

1. All equipment used for mixing and injecting grout and concrete shall be furnished by the Contractor. The power supply and equipment and the layout thereof shall meet all applicable requirements of local, State, and Federal regulations and codes, including those related to safety.
2. The Contractor can use a premixed grout delivery service or an on-site batch mixing facility, if approved in advance by the Government. In either case, the grout shall be well mixed and shall be free of hardened grout or foreign materials larger than a No. 16 U.S. Standard screen. The Contractor shall provide all necessary pumps, mixers, compressors, tanks, meters, valves, hoses, pipes, fittings, tools and other miscellaneous items to provide a continuous supply of grout and to maintain accurate control and measurement. The grout plant must be capable of providing 50 cubic yards of grout per hour to each operating pump. The grout supply pipe shall be metal or plastic stiff enough to maintain the tip below the level of grout during placement. The type and diameter of the grout supply pipe to be used shall be determined by the Contractor and approved by the

Professional. If, at any time, it is determined that the pipe is of insufficient diameter, then the Professional will direct the Contractor to use a larger diameter pipe.

3. The equipment used to mix grout and concrete shall have suitable metering devices to accurately and continuously measure the proportions of all components of the mix including water at the time of injection. The water meter shall be a non-resettable, continuous flow water meter and must meet the approval of the Professional.
4. All flow measurement and mix proportioning equipment shall have a recent calibration and shall be field calibrated periodically during the project.

C. PROCEDURES

1. The Contractor shall perform periodic soundings during grout and concrete injection operations to determine the levels of injected materials in the holes, and maintain the discharge points of the injection pipes below the surface level of the grout or concrete. Should the Professional suspect or observe that the grout or concrete take is moving off-site, pumping shall be halted and alternative measures will be directed by the Professional.
2. Barrier holes are the outer two rows of boreholes located along the perimeter of the area to be stabilized. Interior holes are boreholes located within the area bounded by the barrier holes. In general, low slump concrete is to be injected in void stages of barrier holes and grout is to be injected in non-void stages of barrier holes and all stages of interior holes. High slump concrete may be injected into void stages of interior holes if directed by the Professional. Barrier holes shall be completed prior to starting injection in interior holes unless otherwise approved by the Professional.
3. Injection sequence and injection materials and procedures for each hole will be determined by the Professional. Do not inject more than 50 cubic yards of concrete shall be injected into a single barrier borehole in any one day. Inject grout or concrete continuously into an interior borehole until the borehole fills to the base of the casing or until the Professional directs the Contractor to terminate injection into that borehole. The Professional may terminate injection in any borehole at any time that he determines is appropriate to attempt to limit undesirable loss of injection materials outside the area of stabilization. A minimum period of 12 hours shall elapse between subsequent injection stages in a given borehole.

4. All injection shall be performed using the gravity injection technique described herein. The grout or concrete supply pipe shall be extended to the bottom of the hole, filled with grout or concrete and slowly withdrawn from the borehole, as the grout or concrete rises. Additional material shall be pumped into the pipe as it is withdrawn such that the pipe is always full and the bottom of the pipe is always maintained within the grout or concrete being placed. Free fall of grout or concrete through the injection stage is prohibited.
5. Grouting above the mine shall continue to the top of rock unless large takes are encountered, in which case the mix may be thickened. If directed by the Professional, fine or coarse aggregate shall be placed in the hole by shoveling or other methods approved by the Professional while grouting continues.
6. No flushing of water down the hole or into the mine will be allowed once injection has commenced in that borehole. The Contractor shall inject the grout in such a way as to not coat or foul the borehole until mine-level voids are filled and the grout backs up into the borehole.
7. Concrete shall be placed within the following time limits after the introduction of the cement:
 - a. 90 minutes when the ambient air temperature is 80oF or less.
 - b. 60 minutes when the ambient air temperature is over 80oF.
8. Once the injection holes have been grouted or concrete placed to the ground surface, the casing shall be removed. Concurrently with or immediately after removal of the casing, the remaining open hole in the overburden shall be filled with grout or concrete to the ground surface. If settlement of the filler occurs later, the hole shall be refilled to the ground surface.

C. TESTING

1. The Contractor shall prepare grout and concrete test cylinders in accordance with ASTM C 31 at a rate of four per 50 cubic yards placed in a single pour or four for each pour less than 50 cubic yards. The Professional reserves the right to require preparation of cylinders from any batch. The samples shall be obtained at the injection hole location or at the batch plant as directed by the Professional. The Contractor shall have the cylinders tested according to ASTM C 39 at 3 (two samples), 7, and 28 days cure and shall report the results to the Professional in writing within 48 hours of the completion of each test. Test

cylinders shall also be prepared at each plant or field change of the water-cement-fly ash ratio. The slump of each load or batch of concrete shall be determined using the procedures of ASTM C 143. The fluidity of each load or batch of grout shall be determined according to ASTM C 939. The slump or fluidity of the mix shall be tested by the Contractor when requested by the Professional. A record of all test results shall be made. The cost of this testing and reporting shall be the responsibility of the Contractor.

2. If the Contractor desires to test cubes of grout and has completed the previous testing discussed under "Mix Designs," then he can mold and test cube samples of grout at the frequency specified above for cylinders in accordance with ASTM C 109.

D. RECORDS AND FORMS

1. The Contractor shall maintain daily labor and material records on forms suitable to the Professional. The records shall include the actual measured quantities of each component of injection materials, including water.
2. The Contractor shall record the quantities of concrete and grout injected into each injection hole, using forms subject to the approval of the Professional.
3. Daily records of labor, mix proportions, slump measurements, fluidity measurements, and injection quantities shall be submitted to the Professional within one day of injection.

E. METHOD OF MEASUREMENT

1. Purchasing, Handling and Placing Concrete: Payment for purchasing, handling and placing concrete, and all associated costs will be based on the number of cubic yards of concrete injected. This shall include purchase, mixing and transportation of high and low slump concrete from batch plant to the job site. The volume cannot exceed the volume based on material dry weight(s) delivered and proportioned per cubic yard based on the mix design submitted.
2. Purchasing, Handling and Placing Grout: Payment for purchasing, handling and placing grout, and all associated costs will be based on the number of cubic yards of grout injected. Volume cannot exceed the volume based on material dry weight(s) delivered and proportioned per cubic yard based on mix design submitted.

3. Purchasing, Handling and Placing Fine Aggregate: Payment for supplying, handling and placing fine aggregate will be made based on the number of tons of fine aggregate placed. This shall include the cost of all material, labor, transportation, tools and equipment and associated costs required for purchasing, handling, and placing the fine aggregate into the boreholes. Any work required to clear boreholes where the fine aggregate has "bridged" or otherwise blocked the borehole is also included as part of this item. This item does not include fine aggregate used in grout or concrete mixes.
4. Purchasing, Handling and Placing Coarse Aggregate: Payment for supplying, handling and placing coarse aggregate will be made based on the number of tons of coarse aggregate placed. This shall include the cost of all material, labor, transportation, tools and equipment and associated costs required for purchasing, handling, and placing the coarse aggregate into the boreholes. Any work required to clear boreholes where the coarse aggregate has "bridged" or otherwise blocked the boreholes is also included as part of this item. This item does not include coarse aggregate used in concrete mixes.
5. Accelerator: Measurement of an accelerator will be made per pound based on the weight exhibited by the admixture in its commercial form prior to addition of water or to the injection mix. This shall include the cost of purchase and transportation of the admixture to the site, and the cost of storing and handling the admixture.

F. BASIS OF PAYMENT

1. Purchasing, Handling and Placing Low-Slump Concrete: Payment will be made at the contract unit price per cubic yard.
2. Purchasing, Handling and Placing High-Slump Concrete: Payment will be made at the contract unit price per cubic yard.
3. Purchasing, Handling and Placing Grout: Payment will be made at the contract unit price per cubic yard.
4. Purchasing, Handling and Placing Fine Aggregate: Payment will be made at the contract unit price per ton.
5. Purchasing, Handling and Placing Coarse Aggregate: Payment will be made at the contract unit price per ton.
6. Accelerator: Payment will be made at the contract unit price per pound.

3.17 SECONDARY DRILLING

A. SCOPE

1. The Contractor shall perform secondary drilling as required by the Professional to determine the effectiveness of the injection operations or to determine subsurface conditions and potentially grout encountered voids. The borehole shall be backfilled with grout upon completion as based on these specifications

B. METHOD OF MEASUREMENT

1. Measurement of secondary drilling for payment will be in lineal feet from the ground surface to the actual depth drilled as measured along the axis of the hole. This shall include the cost of furnishing all labor, materials, pipe, casing, tools, and equipment required for drilling, and backfilling the holes including all incidental work connected therewith.

C. BASIS OF PAYMENT

1. Payment will be made at the contract unit price per lineal foot.

3.18 BOREHOLE PHOTOGRAPHY

A. SCOPE

1. The Contractor shall retain the services of a qualified borehole video camera service to make and record on VHS tape (or digital media) horizontal visual observations with combined audio records through boreholes of the effectiveness of the filling of the mine voids or to view conditions at mine level prior to injection. Provide a borehole television camera system for video inspection of the overburden rock and mine voids with the following features:

- a. Accessibility through a 6-inch diameter borehole to a depth of 100 feet.
- b. Video with high resolution and sharpness on VHS or DVD format.
- c. Remotely controlled focus and internal variable light source.
- d. Reel mounted cable with depth increments.

- e. On-screen indicator of depth.
 - f. Portable video monitor for field viewing.
 - g. Audio input capability.
 - h. Lens and light source suitable for inspecting the walls of the borehole in the overburden rock.
 - i. Right angle lens and light source suitable for inspecting mine voids to a minimum distance of 30 feet from the borehole.
 - j. Audio downhole compass bearing of the direction that the lens is facing.
 - k. Waterproof light source capable of being lowered through a 6-inch borehole to a depth of 100 feet, in addition to the camera's light source.
2. These services shall be provided when requested by the Professional. The name and qualifications of the company providing these services shall be provided with the bid documents.

B. METHOD OF MEASUREMENT

1. Measurement of borehole photography will be made on a per day basis with a minimum of six hours on site camera work for each day the Contractor is directed by the Professional to use the borehole camera. This shall include all labor, materials, equipment, transportation, setup, recording, camera usage, and all other associated items and costs necessary to insert and remove the camera and to produce and record and provide to the Professional two copies of VHS video tapes or DVD of the conditions in the boreholes.

C. BASIS OF PAYMENT

1. Payment will be made at the contract unit price per day.

- - - END - - -

Solicitation No. VA-101-10-RP-0130

VAPHS - University Drive

Division

Research Office Building- Building #30

08-18-10

DRAWINGS

Mine Grouting Plan, Proposed Research Office Building, VAPHS -
University Drive Division, Drawing Number CM1-100, Project Number
646CA2500R

CONTRACTOR'S BID SHEET**GROUT STABILIZATION OF ABANDONED UNDERGROUND MINE***PROJECT: VA Hospital Research Office Building, Oakland Campus**LOCATION: Pittsburgh, Pennsylvania*

Item Description	Measure	Unit of Quantity	Estimated price	Unit Price	Estimated Cost
Mobilization/ Demobilization	lump sum	1			
Site Preparation	lump sum	1			
Drilling and Casing Vertical Injection Holes through Overburden above Top of Rock	lineal foot	1,600			
Drilling and Casing Inclined Injection Holes through Overburden above Top of Rock	lineal foot	700			
Drilling Vertical Injection Holes in Rock	lineal foot	9,500			
Drilling Inclined Injection Holes in Rock	lineal foot	4,000			
Purchasing, Handling and Placing Low Slump Concrete	cubic yard	600			
Purchasing, Handling and Placing High Slump Concrete	cubic yard	400			
Purchasing, Handling and Placing Grout	cubic yard	3,200			
Purchasing, Handling and Placing Fine Aggregate	ton	10			
Purchasing, Handling and Placing Coarse Aggregate	ton	10			
Accelerator	pound	10			
Secondary Drilling (15 boreholes)	lineal foot	1,500			
Borehole Photography	day	10			
Mobilization for additional drilling rig(s) (in addition to first 2)	lump sum	1			

SECTION 31 68 13
ROCK FOUNDATION ANCHORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rock anchors.

B. Related Sections include but are not necessarily limited to:

1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 1 - General Requirements.

C. All anchors indicated on the Drawings or specified to be rock anchors obtaining their required tension load carrying capacity from embedment into rock.

D. Unit Prices:

1. Measurement:

- a. Length of anchors for payment to be measured from farthest end embedded in the ground to a point 6 inches beyond exterior face of anchor or baseplate.
- b. Anchor lengths extending beyond this 6 inch dimension will be considered as waste.

2. Payment:

- a. Contract bid price for anchors to be based on the total lineal footage of anchors indicated on the Foundation Plan(s) along with the minimum number of anchor load tests required by this Specification Section.
- b. Bid price to include all costs for material, labor, equipment and accessories required for complete anchor installation and anchor load testing as shown on the Drawings and indicated in this Specification Section.
- c. Adjustment to bid price for anchor lengths in place and anchor load tests to be made in accordance with unit prices in the Bid Proposal.
 - 1) No price adjustment will be made for individual anchors in place but will be made on the total lineal footage of anchors installed.

- d. Payment will be made for the following:
 - 1) Drilling any anchor hole which must be abandoned due to unexpected subsurface conditions encountered such as obstructions, etc.
 - 2) Additional anchors and structural members required due to in-place anchors not being capable of being past tensioned to required loadings.
- e. No payment will be made for pile load tests where any portion of the testing system fails prior to the test being completed.
 - 1) No payment will be made for failing test anchors placed at locations of production anchors or for additional anchors and structural members required due to these failing test anchors.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

- 1. American Institute of Steel Construction (AISC):
 - a. Manual of Steel Construction.
- 2. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - c. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - d. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement (Including Supplementary Requirements S1).
 - e. A722, Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete.
 - f. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - g. C33, Standard Specification for Concrete Aggregates.
 - h. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - i. C150, Standard Specification for Portland Cement.
- 3. Federal Highway Administration (FHWA):
 - a. "Ground Anchors and Anchored Systems" Pub No. FHWA-IF-99-015, June 1999.

B. Qualifications:

1. Anchor installer to have a minimum of five (5) years of experience in the installation and construction of the type of anchors shown on the Drawings and required by the Specifications.

1.3 DEFINITIONS

- A. Anchor Bond Length: That length of anchor which is bonded to a passive subgrade zone and which transmits the required anchor tension load to subgrade.
- B. Anchor Embedment Length: That portion of the total length of anchor extending into and surrounded by subgrade {rock} {soil} material.
- C. Production Anchors: Anchors indicated on Drawings or otherwise required for support of structural members.
- D. Installer or Applicator:
 1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 2. Installer and applicator are synonymous.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
- B. Submit record of three (3) of Contractor's past successful installations of required type of anchor under similar soil conditions.
- C. Submit manufacturer and type of proposed anchor along with proposed anchor corrosion protection.
- D. Submit Shop Drawings indicating proposed sizes and types of steel anchor or baseplates.
- E. Submit Shop Drawings showing all bracing members and their connections.
- F. Submit manufacturer and type of proposed epoxy resin.
- G. Submit manufacturer and type of proposed fast setting leveling grout.
- H. Submit concrete grout mix design.
- I. Submit results of all anchor load tests for Engineer information.

- J. Submit strength test results of concrete grout placed in the field.
- K. Submit recommended anchor embedment and bond length into rock as established by Soils Engineer for Engineer information.
- L. Submit anchor report for all in place production anchors.
 - 1. Submittal is for information only.

1.5 PROJECT CONDITIONS

- A. Do not begin anchor installation until the earthwork demolition in the area where anchors are to be installed has been completed as shown on the Drawings and indicated in these Specifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Rock Anchors:
 - a. Dywidag threadbar reinforcing steel as manufactured by Dywidag Systems International, USA, Inc.
 - 2. Fast setting leveling grout under steel anchor or base plates:
 - a. Super Por-rok as manufactured by Hallemite, Lehn and Fink Industrial Products Division of Sterling Drug Inc.
 - 3. Epoxy resin for coating and bonding anchors to subgrade:
 - a. Celltite by Celltite, Inc.
- B. Submit request for substitution in accordance with Specification Section 01640.

2.2 ANCHOR CAPACITY

- A. Allowable working tension load carrying capacity for each required production anchor to be 37,600 LBS.

2.3 MATERIALS

- A. Rock Anchors:
 - 1. No. 10 threadbar reinforcing steel anchors conforming to ASTM A615, Grade 60.
- B. Steel Anchor or Baseplates: ASTM A36 or ASTM A572.
- C. Washers Under Anchor Locking Nuts:
 - 1. Beveled washers: Steel or malleable iron of sufficient strength to prevent gouging of washer while tightening locking nut.

2. Flat washers: ASTM A325.
- D. Fast setting leveling grout under steel anchor or baseplates: Minimum 28-day compressive strength to be 5000 psi.
- E. Concrete grout for coating and bonding anchors to subgrade:
 1. Cement: ASTM C150, Type I, II, or III.
 2. Aggregates:
 - a. ASTM C33 well graded from fine to coarse.
 - b. Aggregates to be natural not manufactured.
 3. Water: Potable, clean, free of oils, acids, and organic matter.
 4. Water content to be minimum necessary for proper pumping of grout with a maximum water cement ratio by weight of 0.45.
 5. Minimum 28-day compressive strength to be 5000 psi with a higher 28-day compressive strength provided if required to allow anchors to be post tensioned to specified tension loads.
 6. Do not use expansive agents or admixtures in the grout mix.
- F. Prior to beginning installation of anchors, submit the proposed concrete grout mix design to Engineer for review.
 1. Mix design to contain the following information:
 - a. Sieve analysis and source of aggregates.
 - b. Test for aggregate organic impurities.
 - c. Proportioning of all materials.
 - d. Type of cement along with mill certificate for the cement.
 - e. One (1) seven (7) day and two (2) 28-day compression test results using 6 inch diameter by 12 inch high cylinders for testing.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Do not include in bid price the cost of inspection services as stated herein as being performed by a Soils Engineer.

3.2 LINES AND LEVELS

- A. Complete necessary excavation and furnish all lines and levels necessary for completion of anchor installation.

3.3 DETERMINATION OF ANCHOR LENGTH(S) TO BE INSTALLED

- A. Perform no less than two (2) load tests on anchors to determine required anchor bond length and embedment length into subgrade

necessary to provide required allowable working tension load carrying capacity.

1. Perform load tests prior to installing production anchors.
 - a. Install test anchors at locations with anchor bond length and embedment length into subgrade all as determined and directed by Soils Engineer.
 2. All components and details of the test anchors to be the same as proposed and required for use in production anchors.
 3. When approved, test anchors may be placed at locations required for production anchors.
 - a. If test anchors are placed at these locations and for any reason should be found to be inadequate, install additional anchor or anchors adjacent to the inadequate anchor as directed by Engineer.
 - b. Provide additional structural members as required due to the location of an additional anchor or anchors and as directed by Engineer.
 - c. Additional anchors and structural members to be provided and installed at no additional expense to Owner.
- B. Entire anchor load testing program to be under the direction and supervision of the Soils Engineer.
1. When establishing anchor bond length and anchor embedment length into subgrade for test anchors, take into account the reduced tension capacity of an anchor due to "group action" caused by the close proximity of the locations of adjacent production anchors.
 2. Apparatus for load testing anchors to be of such design that not only is the anchor tested for its capability of supporting the required loading but also that the subgrade material surrounding the anchor is tested for its capability of supporting the required loading.
 3. Contractor to design test anchor setup.
 - a. Entire apparatus for load testing anchors to be supplied by Contractor.
- C. Load test anchors in accordance with the FWHA "Ground Anchors and Anchored Systems", Pub No. FWHA-IF-99-015, June 1999.
1. Provide a calibration chart not more than 20 days old for hydraulic jack and pressure gage used for the load tests.

2. Entire load test setup to have adequate capacity for testing anchors to twice their specified allowable working tension load carrying capacity.
 3. Provide a dial gage to measure anchor movement during load testing.
 - a. All readings, taken by Soils Engineer, to be verified and signed by Contractor, and a copy sent to Engineer for information.
 4. Do not begin load tests until material used to bond anchors to subgrade has cured sufficiently to be capable of transferring the required test loads from the anchor to the subgrade.
- D. Load test anchors to a minimum of 150 percent the specified allowable working tension load carrying capacity as stated in this Section.
- E. Criteria for establishing failure of test anchors will be as determined by Soils Engineer.
- F. In the event of failure of test anchor apparatus setup, repeat load test at no additional expense to Owner.
- G. Based on the results of the anchor load tests, the anchor bond length and anchor embedment length into subgrade for production anchors to be installed at required locations to be as directed by the Soils Engineer.
1. Send anchor load test results to Engineer for information.
- H. If, during the installation of the production anchors, subgrade conditions are found to be different from those encountered during installation of the test anchors, or if production anchors are not capable of being post tensioned to the required loads as specified herein, revise the anchor bond length and/or the anchor embedment length into subgrade for the anchor being installed as directed by the Soils Engineer.
1. If anchor is found to be not capable of being post tensioned to the required loads, install additional anchor or anchors as directed by Engineer with anchor bond length and embedment length as directed by Soils Engineer.
 2. Install additional structural members required by placement of additional anchor or anchors as directed by Engineer.
 - a. Allow Soils Engineer to witness installation of all production anchors.

3.4 ADDITIONAL ANCHOR LOAD TESTS

- A. In addition to anchor load test requirements for Base Bid, Soils Engineer may require installation and testing of additional test anchors loaded and tested in accordance with requirements of this Specification.

3.5 ANCHOR INSTALLATION AND DETAIL REQUIREMENTS

A. Equipment:

1. Drilling equipment shall be adequate for providing the required bore holes in the subgrade encountered.
2. All drilling is to be done by rotary drilling.
3. Grouting equipment to be capable of continuous mechanical mixing that will produce a uniform and thoroughly mixed grout at the required pressures.
4. Post tensioning of anchors to be accomplished by use of a hydraulic jack properly calibrated, capable of applying the required tension loads and including appropriate gages to indicate the load applied and to measure anchor elongation and movements.

B. Anchor Corrosion Protection:

1. All installed anchors for their entire length shall be covered with a polyvinyl chloride (PVC) sheathing gastight to prevent corrosive substances reaching the anchor steel.
2. A PVC seal end cap to be placed over the bottom end of each anchor along with a gastight PVC sealing cap placed over the anchor nut at each anchor.
3. PVC required protection for anchors to be as standard with anchor manufacturer subject to review and approval by Engineer.

C. Anchor Placement:

1. Before anchor placement, each anchor to be thoroughly cleaned to permit adequate bonding of the anchor to the bonding material.
2. Do not install any anchors which are bent, cracked, of insufficient length, of reduced cross section due to any reason, or damaged in any way which would decrease the tension load carrying capacity of the anchor.
3. Install anchors at the indicated locations, to the embedment length as directed by the Soils Engineer and at the indicated angle of inclination.

- a. Where the angle of inclination is not shown on the Drawings, an anchor shown horizontally shall be placed at 90 degrees with true vertical and an anchor shown vertically shall be placed at 90 degrees with true horizontal.
 - b. A tolerance of +3 degrees will be allowed on the indicated or specified angle of inclination.
 - 4. All anchors to be continuous full length without splices.
 - 5. Provide a washer under the anchor locking nut.
 - a. Washer to be beveled where anchor is not 90 degrees to anchor plate.
 - 6. Locking nuts shall be hexagonal head of the heavy duty type, conforming to the requirements of or in accordance with the manufacturer's specification for special nuts to be used with anchors supplied.
 - a. Nuts to be capable of developing an ultimate strength of not less than 125 percent of the minimum yield strength of the anchor to which it is attached.
- D. Concrete Grout for Coating and Bonding Anchors to Subgrade:
- 1. Place grout continuously from bottom of hole to top of hole using tremie method until grout overflows top of hole.
 - a. Place grout in such a manner to ensure that grout completely fills the bore hole and completely coats the anchor.
 - 2. The entire required anchor bond length to be pressure grouted using sufficient pressure to allow the required post tensioned loads to be placed on the anchors.
 - a. Do not place required post tensioning loads on anchors until concrete grout has obtained sufficient strength to be capable of transferring the post tensioning loads from the anchor to the adjacent subgrade material.
 - 3. The bore holes for soil anchors to be steel encased as required to prevent the intrusion of soil, water or any other material into the holes that would prevent the required bonding of the anchors to the subgrade.
 - a. Withdraw steel casing slowly during grout placement in such a manner that grout completely fills the bore hole and completely coats the anchor.

4. Make three (3) 6 inch diameter by 12 inch high concrete grout test cylinders for each consecutive 10 production anchors installed.
 - a. Make cylinders in accordance with ASTM C31.
 - b. Test one (1) cylinder at seven (7) days and two (2) cylinders at 28 days.
 - 1) Perform tests in accordance with ASTM C39.
 - c. Send test results indicating production anchors they represent to Engineer.

E. Steel Anchor or Baseplates with Leveling Grout:

1. Provide anchor or baseplates of sufficient size and thickness to be capable of transferring the required post tensioning loads to the anchors without exceeding the specified allowable bearing stress on the leveling grout when such grout is required beneath the anchor or baseplate, and without exceeding the allowable bending stress for the steel plate as stated in the AISC Manual of Steel Construction.
2. When indicated on the Drawings or otherwise required, fully bed all anchor or baseplates on a minimum 1 inch thick layer of leveling grout.
 - a. Leveling grout to be a fast setting cement grout.
3. Required post tensioning anchor loads to not impose a bearing stress on the leveling grout which exceeds 0.3 times the compressive strength of the grout at the time of post tensioning.
 - a. Minimum compressive strength of leveling grout at time of post tensioning to be 3000 psi.

F. Application, Measurement, and Magnitude of Post Tensioning Forces
Required for Production Anchors:

1. All production anchors indicated on Drawings or specified (except load test anchors) to be post tensioned to 150 percent of the required allowable working tension load carrying capacity indicated for each production anchor as stated in this Specification Section.
2. Maintain this 150 percent load on each production anchor for a minimum period of 5 minutes.
 - a. Measure anchor movement by dial gage during the application of the 150 percent load and while maintaining this load for the minimum 5 minute period.

- b. If during the five (5) minute period, the anchor movement is less than 0.03 IN, the 150 percent load can be lowered and locked at the required post tensioning load stated below.
 - c. If the anchor movement is greater than 0.03 inch during the five (5) minute period, then the 150 percent load to be maintained until the anchor movement decreases to an acceptable value as determined by the Soils Engineer.
- 3. When approval to do so is obtained from the Soils Engineer, reduce the 150 percent load at each production anchor to a post tension force which will remain permanently in each production anchor equal to 110 percent of the required allowable working tension load carrying capacity giving full consideration to all possible losses of the applied post tensioning force.
- 4. Allow the installation and post tensioning of all production anchors to be witnessed and approved by the Soils Engineer.
- 5. All anchors to be post tensioned by means of a hydraulic jack.
 - a. Post tensioning forces to be determined by both of the following methods:
 - b. Measurement of anchor elongation.
 - 1) Required elongation to be determined from average load elongation curves for type and size of anchors being installed.
 - c. Observation of post tensioning force indicated on a calibrated gage attached to the hydraulic jack applying the post tensioning force.
 - 1) Discrepancies of more than five (5) percent between elongation and gage reading to be investigated and remedied.
 - 2) Movement of the structural system during the application of the post tensioning forces to be taken into account.

3.6 ROCK ANCHORS

- A. Place each rock anchor in a 4 inch diameter bored hole.
 - 1. Each bore hole to be pressure tested to determine water leakage before anchor or bonding material can be installed.
 - 2. When water leakage is determined by Soils Engineer to be excessive, completely fill bore hole with consolidation concrete grout.
 - 3. Allow grout to harden and then redrill hole to original diameter.
 - 4. Recheck for water leakage.

5. Repeat consolidation grouting, redrilling and leakage testing until Soils Engineer approves bore hole for water tightness.
 6. Consolidation concrete grout to have a 5000 psi minimum 28-day compressive strength.
 7. Allow Soils Engineer to witness the drilling of all bore holes.
- B. Completely coat and bond all rock anchors to rock subgrade with concrete grout for entire anchor embedment length.
1. Prior to placing anchor and grout in bore hole, ensure that hole is free of water, loose rock particles or any other item that might weaken the bonding of the anchor to the rock subgrade.
 2. Clean bore holes as necessary.
 3. See this Specification Section for concrete grout requirements.

3.7 ANCHOR REPORT

- A. During the installation of the production anchors, provide an anchor report for each production anchor installed recording for each anchor the following information:
1. Anchor type, manufacturer, diameter and length.
 2. Total anchor embedment length into {rock} {soil}.
 3. Anchor bore hole diameter.
 4. Whether or not consolidation grouting or steel encasing was required for bore hole.
 5. Anchor bond length.
 6. Quantity of epoxy resin placed in bore hole.
 7. Quantity of concrete grout placed in bore hole.
 8. Hydraulic jacking force reading at 150 percent of required allowable working tension load carrying capacity with all accompanying anchor movement measurements.
 9. Hydraulic jacking force reading at 110 percent of required allowable working tension load carrying capacity.
- B. The anchor report to be signed by the Contractor with copies sent to Engineer and Owner.

- - - E N D - - -

SECTION 32 05 23
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section shall cover site work concrete constructed upon the prepared subgrade and in conformance with the lines, grades, thickness, and cross sections shown. Construction shall include the following:
1. Curb and combination curb and gutter wheel stop.
 2. Pedestrian Pavement: Walks grade slabs wheelchair curb ramps.
 3. Vehicular Pavement: Driveways.
 4. Precast concrete bollards.
 5. Equipment pads.

1.2 RELATED WORK

- A. Laboratory and Field Testing Requirements: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Section 31 20 00, EARTH MOVING.
- C. Concrete Materials, Quality, Mixing, Design and Other Requirements: Section 03 30 00, CAST-IN-PLACE-CONCRETE.
- D. Metal Components of Steps (Nosing and Railing): Section 05 50 00, METAL FABRICATIONS.
- E. Finishes: Section 09 06 00, SCHEDULE OF FINISHES.

1.3 DESIGN REQUIREMENTS

- A. Design all elements with the latest published version of applicable codes.

1.4 WEATHER LIMITATIONS

- A. Placement of concrete shall be as specified under Article 3.8, COLD WEATHER and Article 3.7, HOT WEATHER of Section 03 30 00, CAST-IN-PLACE CONCRETE.

1.5 SELECT SUBBASE MATERIAL JOB-MIX

- A. The Contractor shall retain and reimburse a testing laboratory to design a select subbase material mixture and submit a job-mix formula to the Resident Engineer, in writing, for approval. The formula shall include the source of materials, gradation, plasticity index, liquid limit, and laboratory compaction curves indicating maximum density at optimum moisture.

1.6 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

- B. Manufacturers' Certificates and Data certifying that the following materials conform to the requirements specified.
1. Expansion joint filler
 2. Hot poured sealing compound
 3. Reinforcement
 4. Curing materials
 5. Concrete protective coating.
- C. Data and Test Reports: Select subbase material.
1. Job-mix formula.
 2. Source, gradation, liquid limit, plasticity index, percentage of wear, and other tests as specified and in referenced publications.

1.7 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Refer to the latest edition of all referenced Standards and codes.
- B. American Association of State Highway and Transportation Officials (AASHTO):
- M31.....Deformed and Plain Billet Steel Bars for
Concrete Reinforcement (ASTM A615/A615M-96A)
- M55M/55M.....Welded Steel Wire Fabric for Concrete
Reinforcement (ASTM A185)
- M147.....Materials for Aggregate and Soil-Aggregate
Subbase, Base and Surface Courses (R 1996)
- M148.....Liquid Membrane-Forming Compounds for Curing
Concrete (ASTM C309A)
- M171.....Sheet Materials for Curing Concrete (ASTM C171)
- M182.....Burlap Cloth Made from Jute or Kenaf
- M213.....Preformed Expansion Joint Fillers for Concrete
Paving and Structural Construction
(Non-extruding and Resilient Bituminous Type)
(ASTM D1751)
- M233.....Boiled linseed oil mixture for treatment of
Portland cement concrete.
- T99.....Moisture-Density Relations of Soils Using a 2.5
kg. (5.5 lb) Rammer and a 305 mm (12 in.) Drop
- T180.....Moisture-Density Relations of Soils Using a 4.54
kg (10 lb.) Rammer and a 457 mm (18 in.) Drop
- C. American Society for Testing and Materials (ASTM):
- C94/C94M.....Ready-Mixed Concrete

C143/C143M.....Slump of Hydraulic Cement Concrete

PART 2 - PRODUCTS**2.1 GENERAL**

- A. Concrete shall be Type C, air-entrained as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, with the following exceptions:

<u>TYPE</u>	<u>MAXIMUM SLUMP*</u>
Curb & Gutter	75 mm (3")
Pedestrian Pavement	75 mm (3")
Vehicular Pavement	50 mm (2") (Machine Finished) 100 mm (4") (Hand Finished)
Equipment Pad	75 to 100 mm (3" to 4")
* For concrete to be vibrated: Slump as determined by ASTM C143. Tolerances as established by ASTM C94.	

2.2 REINFORCEMENT

- A. The type, amount, and locations of steel reinforcement shall be as shown on the drawings and in the specifications.
- B. Welded wire-fabric shall conform to AASHTO M55.
- C. Dowels shall be plain steel bars conforming to AASHTO M31 or M42. Tie bars shall be deformed steel bars conforming to AASHTO M31 or M42.

2.3 SELECT SUBBASE

- A. Subbase material shall consist of select granular material composed of sand, sand-gravel, crushed stone, crushed or granulated slag, with or without soil binder, or combinations of these materials conforming to AASHTO M147, Grading E or F. Thickness of subbase shall be as shown on Drawings.
- B. Materials meeting other gradations than that noted will be acceptable whenever the gradations are within a tolerance of three to five percent, plus or minus, of the single gradation established by the job-mix formula.
- C. Subbase material shall produce a compacted, dense-graded course, meeting the density requirement specified herein.

2.4 FORMS

- A. Use metal or wood forms that are straight and suitable in cross-section, depth, and strength to resist springing during depositing and consolidating the concrete, for the work involved.

- B. Do not use forms if they vary from a straight line more than 3 mm (1/8 inch) in any 3000 mm (ten foot) long section, in either a horizontal or vertical direction.
- C. Wood forms should be at least 50 mm (2 inches) thick (nominal). Wood forms shall also be free from warp, twist, loose knots, splits, or other defects. Use approved flexible or curved forms for forming radii.

2.5 CONCRETE CURING MATERIALS

- A. Concrete curing materials shall conform to one of the following:
 - 1. Burlap conforming to AASHTO M182 having a weight of 233 grams (seven ounces) or more per square meter (yard) when dry.
 - 2. Impervious Sheeting conforming to AASHTO M171.
 - 3. Liquid Membrane Curing Compound conforming to AASHTO M148 (ASTM C309), Type 1 and shall be free of paraffin or petroleum.

2.6 EXPANSION JOINT FILLERS

- A. Material shall conform to AASHTO M213.

2.7 CONCRETE PROTECTION MATERIAL

- A. Linseed oil mixture shall conform to AASHTO M233.

2.8 PRECAST CONCRETE BOLLARDS

- A. Basis-Of-Design Product: Subject to compliance with requirements, provide Wausau Tile, Inc.; TF6016 or approved equivalent.
- B. Materials:
 - 1. Portland Cement: ASTM C150.
 - 2. Aggregates: ASTM C 133.
 - 3. Pigments: Inorganic, resistant to alkalinity in accordance with manufacturer's printed instructions.
 - 4. Sleeve: ASTM A53, standard weight (Schedule 40) steel pipe.
 - 5. Size: As indicated on Drawings.
 - 6. Color: Refer to Section 09 06 00, SCHEDULE OF FINISHES.

PART 3 - EXECUTION

3.1 SUBGRADE PENETRATION

- A. Prepare, construct, and finish the subgrade as specified in Section 31 20 00, EARTH MOVING.
- B. Maintain the subgrade in a smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

3.2 SELECT SUBBASE

- A. Mixing: Proportion the select subbase by weight or by volume in quantities so that the final approved job-mixed formula gradation, liquid limit, and plasticity index requirements will be met after subbase course has been placed and compacted. Add water in approved

quantities, measured by weight or volume, in such a manner to produce a uniform blend.

B. Placing:

1. Place the mixed material on the prepared subgrade in a uniform layer to the required contour and grades, and to a loose depth not to exceed 200 mm (8 inches), and that when compacted, will produce a layer of the designated thickness.
2. When the designated compacted thickness exceeds 150 mm (6 inches), place the material in layers of equal thickness. Remove unsatisfactory areas and replace with satisfactory mixture, or mix the material in the area.
3. In no case will the addition of thin layers of material be added to the top layer in order to meet grade.
4. If the elevation of the top layer is 13 mm (1/2 inch) or more below the grade, excavate the top layer and replace with new material to a depth of at least 75 mm (3 inches) in compacted thickness.

C. Compaction:

1. Perform compaction with approved equipment (hand or mechanical) well suited to the material being compacted.
2. Moisten or aerate the material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.
3. Compact each layer to at least 95 percent or 100 percent of maximum density as determined by AASHTO T180 or AASHTO T99 respectively.

D. Smoothness Test and Thickness Control:

Test the completed subbase for grade and cross section with a straight edge.

1. The surface of each layer shall not show any deviations in excess of 10 mm (3/8 inch).
2. The completed thickness shall be within 13 mm (1/2 inch) of the thickness as shown.

E. Protection:

1. Maintain the finished subbase in a smooth and compacted condition until the concrete has been placed.
2. When Contractor's subsequent operations or adverse weather disturbs the approved compacted subbase, excavate, and reconstruct it with new material meeting the requirements herein specified, at no additional cost to the VA.

3.3 SETTING FORMS

A. Base Support:

1. Compact the base material under the forms true to grade so that, when set, they will be uniformly supported for their entire length at the grade as shown.
2. Correct imperfections or variations in the base material grade by cutting or filling and compacting.

B. Form Setting:

1. Set forms sufficiently in advance of the placing of the concrete to permit the performance and approval of all operations required with and adjacent to the form lines.
2. Set forms to true line and grade and use stakes, clamps, spreaders, and braces to hold them rigidly in place so that the forms and joints are free from play or movement in any direction.
3. Forms shall conform to line and grade with an allowable tolerance of 3 mm (1/8 inch) when checked with a straightedge and shall not deviate from true line by more than 6 mm (1/4 inch) at any point.
4. Do not remove forms until removal will not result in damaged concrete or at such time to facilitate finishing.
5. Clean and oil forms each time they are used.

C. The Contractor's Registered Professional Land Surveyor shall establish and control the alignment and the grade elevations of the forms or concrete slipforming machine operations.

1. Make necessary corrections to forms immediately before placing concrete.
2. When any form has been disturbed or any subgrade or subbase has become unstable, reset and recheck the form before placing concrete.

3.4 EQUIPMENT

- A. The Resident Engineer shall approve equipment and tools necessary for handling materials and performing all parts of the work prior to commencement of work.
- B. Maintain equipment and tools in satisfactory working condition at all times.

3.5 PLACING REINFORCEMENT

- A. Reinforcement shall be free from dirt, oil, rust, scale or other substances that prevent the bonding of the concrete to the reinforcement.
- B. Before the concrete is placed, the Resident Engineer shall approve the reinforcement, which shall be accurately and securely fastened in place with suitable supports and ties. The type, amount, and position of the reinforcement shall be as shown.

3.6 PLACING CONCRETE - GENERAL

- A. Obtain approval of the Resident Engineer before placing concrete.
- B. Remove debris and other foreign material from between the forms before placing concrete. Obtain approval of the Resident Engineer before placing concrete.
- C. Before the concrete is placed, uniformly moisten the subgrade, base, or subbase appropriately, avoiding puddles of water.
- D. Convey concrete from mixer to final place of deposit by a method which will prevent segregation or loss of ingredients. Deposit concrete so that it requires as little handling as possible.
- E. While being placed, spade or vibrate and compact the concrete with suitable tools to prevent the formation of voids or honeycomb pockets. Vibrate concrete well against forms and along joints. Over-vibration or manipulation causing segregation will not be permitted. Place concrete continuously between joints without bulkheads.
- F. Install a construction joint whenever the placing of concrete is suspended for more than 30 minutes and at the end of each day's work.
- G. Workmen or construction equipment coated with foreign material shall not be permitted to walk or operate in the concrete during placement and finishing operations.

3.7 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENT, AND EQUIPMENT PADS

- A. Place concrete in the forms in one layer of such thickness that, when compacted and finished, it will conform to the cross section as shown.
- B. Deposit concrete as near to joints as possible without disturbing them but do not dump onto a joint assembly.
- C. After the concrete has been placed in the forms, use a strike-off guided by the side forms to bring the surface to the proper section to be compacted.
- D. Consolidate the concrete thoroughly by tamping and spading, or with approved mechanical finishing equipment.
- E. Finish the surface to grade with a wood or metal float.
- F. All Concrete pads and pavements shall be constructed with sufficient slope to drain properly.

3.8 PLACING CONCRETE FOR VEHICULAR PAVEMENT

- A. Deposit concrete into the forms as close as possible to its final position.
- B. Place concrete rapidly and continuously between construction joints.
- C. Strike off concrete and thoroughly consolidate by a finishing machine, vibrating screed, or by hand-finishing.

- D. Finish the surface to the elevation and crown as shown.
- E. Deposit concrete as near the joints as possible without disturbing them but do not dump onto a joint assembly. Do not place adjacent lanes without approval by the Resident Engineer.

3.9 CONCRETE FINISHING - GENERAL

- A. The sequence of operations, unless otherwise indicated, shall be as follows:
 - 1. Consolidating, floating, straight-edging, troweling, texturing, and edging of joints.
 - 2. Maintain finishing equipment and tools in a clean and approved condition.

3.10 CONCRETE FINISHING CURB /AND GUTTER

- A. Round the edges of the gutter and top of the curb with an edging tool to a radius of 6mm (1/4 inch) or as otherwise detailed.
- B. Float the surfaces and finish with a smooth wood or metal float until true to grade and section and uniform in textures.
- C. Finish the surfaces, while still wet, with a bristle type brush with longitudinal strokes.
- D. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the surface, while still wet, in the same manner as the gutter and curb top.
- E. Except at grade changes or curves, finished surfaces shall not vary more than 3 mm (1/8 inch) for gutter and 6 mm (1/4 inch) for top and face of curb, when tested with a 3000 mm (10 foot) straightedge.
- F. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.
- G. Correct any depressions which will not drain.
- H. Visible surfaces and edges of finished curb, and combination curb and gutter shall be free of blemishes, form marks, and tool marks, and shall be uniform in color, shape, and appearance.

3.11 CONCRETE FINISHING PEDESTRIAN PAVEMENT

- A. Walks, Grade Slabs, Wheelchair Curb Ramps, Terraces:
 - 1. Finish the surfaces to grade and cross section with a metal float, trowled smooth and finished with a broom moistened with clear water.
 - 2. Brooming shall be transverse to the line of traffic.
 - 3. Finish all slab edges, including those at formed joints, carefully with an edger having a radius as shown on the Drawings.
 - 4. Unless otherwise indicated, edge the transverse joints before brooming. The brooming shall eliminate the flat surface left by the

- surface face of the edger. Execute the brooming so that the corrugation, thus produced, will be uniform in appearance and not more than 2 mm (1/16 inch) in depth.
5. The completed surface shall be uniform in color and free of surface blemishes, form marks, and tool marks. The finished surface of the pavement shall not vary more than 5 mm (3/16 inch) when tested with a 3000 mm (10 foot) straightedge.
 6. The thickness of the pavement shall not vary more than 6 mm (1/4 inch).
 7. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.
- B. Steps: The method of finishing the steps and the sidewalls is similar to above except as herein noted.
1. Remove the riser forms one at a time, starting with the top riser.
 2. After removing the riser form, rub the face of the riser with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Use an outside edger to round the corner of the tread; use an inside edger to finish the corner at the bottom of the riser.
 3. Give the risers and sidewall a final brush finish. The treads shall have a final finish with a stiff brush to provide a non-slip surface.
 4. The texture of the completed steps shall present a neat and uniform appearance and shall not deviate from a straightedge test more than 5 mm (3/16 inch).

3.12 CONCRETE FINISHING FOR VEHICULAR PAVEMENT

- A. Accomplish longitudinal floating with a longitudinal float not less than 3000 mm (10 feet) long and 150 mm (6 inches) wide, properly stiffened to prevent flexing and warping. Operate the float from foot bridges in a sawing motion parallel to the direction in which the pavement is being laid from one side of the pavement to the other, and advancing not more than half the length of the float.
- B. After the longitudinal floating is completed, but while the concrete is still plastic, eliminate minor irregularities in the pavement surfaces by means of metal floats, 1500 mm (5 feet) in length, and straightedges, 3000 mm (10 feet) in length. Make the final finish with the straightedges, which shall be used to float the entire pavement surface.
- C. Test the surface for trueness with a 3000 mm (10 foot) straightedge held in successive positions parallel and at right angles to the direction in which the pavement is being laid and the entire area covered as necessary to detect variations. Advance the straightedge along the

pavement in successive stages of not more than one half the length of the straightedge. Correct all irregularities and refinish the surface.

- D. The finished surface of the pavement shall not vary more than 6 mm (1/4 inch) in both longitudinal and transverse directions when tested with a 3000 mm (10 foot) straightedge.
- E. The thickness of the pavement shall not vary more than 6 mm (1/4 inch).
- F. When most of the water glaze or sheen has disappeared and before the concrete becomes nonplastic, give the surface of the pavement a broomed finish with an approved fiber broom not less than 450 mm (18 inches) wide. Pull the broom gently over the surface of the pavement from edge to edge. Brooming shall be transverse to the line of traffic and so executed that the corrugations thus produced will be uniform in character and width, and not more than 3 mm (1/8 inch) in depth. Carefully finish the edge of the pavement along forms and at the joints with an edging tool. The brooming shall eliminate the flat surface left by the surface face of the edger.
- G. The finish surfaces of new and existing abutting pavements shall coincide at their juncture.

3.13 CONCRETE FINISHING EQUIPMENT PADS

- A. After the surface has been struck off and screeded to the proper elevation, give it a smooth dense float finish, free from depressions or irregularities.
- B. Carefully finish all slab edges with an edger having a radius as shown in the Drawings.
- C. After removing the forms, rub the faces of the pad with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The finish surface of the pad shall not vary more than 3 mm (1/8 inch) when tested with a 3000 mm (10 foot) straightedge.
- D. Correct irregularities exceeding the above.

3.14 JOINTS - GENERAL

- A. Place joints, where shown, conforming to the details as shown, and perpendicular to the finished grade of the concrete surface.
- B. Joints shall be straight and continuous from edge to edge of the pavement.

3.15 CONTRACTION JOINTS

- A. Cut joints to depth as shown with a grooving tool or jointer of a radius as shown or by sawing with a blade producing the required width and depth.

- B. Construct joints in curbs and curb gutters by inserting 3 mm (1/8 inch) steel plates conforming to the cross sections of the curb and curb gutter.
- C. Plates shall remain in place until concrete has set sufficiently to hold its shape and shall then be removed.
- D. Finish edges of all joints with an edging tool having the radius as shown.
- E. Score pedestrian pavement with a standard grooving tool or jointer.

3.16 EXPANSION JOINTS

- A. Use a preformed expansion joint filler material of the thickness as shown to form expansion joints.
- B. Material shall extend the full depth of concrete, cut and shaped to the cross section as shown, except that top edges of joint filler shall be below the finished concrete surface where shown to allow for sealing.
- C. Anchor with approved devices to prevent displacing during placing and finishing operations.
- D. Round the edges of joints with an edging tool.
- E. Form expansion joints as follows:
 - 1. Without dowels, about structures and features that project through, into, or against any site work concrete construction.
 - 2. Using joint filler of the type, thickness, and width as shown.
 - 3. Installed in such a manner as to form a complete, uniform separation between the structure and the site work concrete item.

3.17 CONSTRUCTION JOINTS

- A. Locate longitudinal and transverse construction joints between slabs of vehicular pavement as shown.
- B. Place transverse construction joints of the type shown, where indicated and whenever the placing of concrete is suspended for more than 30 minutes.
- C. Use a butt-type joint with dowels in curb and gutter if the joint occurs at the location of a planned joint.
- D. Use keyed joints with tiebars if the joint occurs in the middle third of the normal curb and gutter joint interval.

3.18 FORM REMOVAL

- A. Forms shall remain in place at least 12 hours after the concrete has been placed. Remove forms without injuring the concrete.
- B. Do not use bars or heavy tools against the concrete in removing the forms. Promptly repair any concrete found defective after form removal.

3.19 CURING OF CONCRETE

- A. Cure concrete by one of the following methods appropriate to the weather conditions and local construction practices, against loss of moisture, and rapid temperature changes for at least seven days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready to install before actual concrete placement begins. Provide protection as necessary to prevent cracking of the pavement due to temperature changes during the curing period. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove and replace the damaged pavement and employ another method of curing as directed by the Resident Engineer.
- B. Burlap Mat: Provide a minimum of two layers kept saturated with water for the curing period. Mats shall overlap each other at least 150 mm (6 inches).
- C. Impervious Sheeting: Use waterproof paper, polyethylene-coated burlap, or polyethylene sheeting. Polyethylene shall be at least 0.1 mm (4 mils) in thickness. Wet the entire exposed concrete surface with a fine spray of water and then cover with the sheeting material. Sheets shall overlap each other at least 300 mm (12 inches). Securely anchor sheeting.
- D. Liquid Membrane Curing:
 - 1. Apply pigmented membrane-forming curing compound in two coats at right angles to each other at a rate of 5 m²/L (200 square feet per gallon) for both coats.
 - 2. Do not allow the concrete to dry before the application of the membrane.
 - 3. Cure joints designated to be sealed by inserting moistened paper or fiber rope or covering with waterproof paper prior to application of the curing compound, in a manner to prevent the curing compound entering the joint.
 - 4. Immediately re-spray any area covered with curing compound and damaged during the curing period.

3.20 CLEANING

- A. After completion of the curing period:
 - 1. Remove the curing material (other than liquid membrane).
 - 2. Sweep the concrete clean.
 - 3. After removal of all foreign matter from the joints, seal joints as herein specified.

4. Clean the entire concrete of all debris and construction equipment as soon as curing and sealing of joints has been completed.

3.21 PROTECTION

- A. The contractor shall protect the concrete against all damage prior to final acceptance by the Government. Remove concrete containing excessive cracking, fractures, spalling, or other defects and reconstruct the entire section between regularly scheduled joints, when directed by the Resident Engineer, and at no additional cost to the Government. Exclude traffic from vehicular pavement until the concrete is at least seven days old, or for a longer period of time if so directed by the Resident Engineer.

3.22 CURING AND PROTECTION

- A. Curing and Protection: Protective Coating - apply protective coating of linseed oil mixture to exposed-to-view concrete surfaces, drainage structures, and features that project through, into, or against the items constructed under this section to protect the concrete against the action of deicing materials.
 1. Application: Complete backfilling and curing operation prior to applying protective coating. Concrete shall be surface dry and thoroughly clean before each application. Give the concrete surface at least two applications. Coverage shall not be more than 11 m²/L (50 square yards per gallon) for first application, and not more than 16 m²/L (70 square yards per gallon) for the second application, except when the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Protect coated surfaces from vehicular and pedestrian traffic until dry.
 2. Precautions: Do not heat protective coating, and do not expose the protective coating to open flame, sparks, or fire adjacent to open containers or applicators. Do not apply material at temperatures lower than 10 C (50 F).

3.23 INSTALLATION - PRECAST CONCRETE BOLLARDS

- A. Install in strict accordance with manufacturer's printed instructions.

3.24 FINAL CLEAN-UP

- A. Remove all debris, rubbish and excess material from the Station.

- - - E N D - - -

SECTION 32 12 16
ASPHALT PAVING**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This work shall cover the composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an aggregate or asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1.2 RELATED WORK

- A. Laboratory and field testing requirements: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Paragraph 3.3 and Section 31 20 00, EARTH MOVING.
- C. Pavement Markings: Section 32 17 23, PAVEMENT MARKINGS.

1.3 INSPECTION OF PLANT AND EQUIPMENT

- A. The Resident Engineer shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

1.4 ALIGNMENT AND GRADE CONTROL

- A. The Contractor's Registered Professional Land Surveyor specified in Section 00 72 00, GENERAL CONDITIONS shall establish and control the pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on the Drawings.

1.5 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
- B. Data and Test Reports:
1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear, and other tests required by Commonwealth of Pennsylvania Department of Transportation (PENNDOT).
 2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other tests required by Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Specifications; Publication 408 current edition.
 3. Job-mix formula.

C. Certifications:

1. Asphalt prime and tack coat material certificate of conformance to Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Publication 408/2003 Edition requirements.
2. Asphalt cement certificate of conformance to Commonwealth of Pennsylvania Department of transportation (PENNDOT); Publication 408/2003 Edition requirements.
3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Specifications; Publication 408/2003 Edition Section 409 for SUPERPAVE Asphalt Mixture Design.

D. One copy of Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Specifications; Publication 408/2003.

E. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

1.6 APPLICABLE PUBLICATIONS

- A. Where conflicts arise between this specification Section and the requirements in the latest version of the PENNDOT Specifications, the PENNDOT Specifications shall take precedence.

PART 2 - PRODUCTS**2.1 GENERAL**

- A. Aggregate base and asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the PENNDOT Publication 408/2003 Edition Material Specifications, including amendments, addenda and errata. Where the term "Engineer" or "Commission" is referenced in the State Highway Specifications, it shall mean the VA Resident Engineer or VA Contracting Officer.

2.2 AGGREGATES

- A. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined. Conform to PennDot Publication 408/2003, Section 703.
- B. Subbase aggregate (where required) maximum size: 38mm(1-1/2").
- C. Base aggregate maximum size:
1. Aggregate Base Course: AASHTO #3 crushed limestone.
 2. Aggregate Choke: AASHTO #2A crushed limestone.
- D. Aggregates for asphaltic concrete paving: Provide a mixture of sand, mineral aggregate, and liquid asphalt mixed in such proportions that the percentage by weight will be within: Conform to PennDot Publication 27,

"Bituminous Concrete Mixtures, Design Procedures, and Specification for Special Bituminous Mixtures."

<u>Sieve Sizes</u>	<u>Percentage Passing</u>
19mm (3/4")	100
9.5mm (3/8")	67 to 85
6.4mm (1/4")	50 to 65
2.4mm (No. 8 mesh)	37 to 50
600µm (No. 30 mesh)	15 to 25
75µm (No. 200 mesh)	3 to 8

E. Plus 64/22 Performance Grade liquid asphalt, conforming to PennDot Publication 37, Specifications for Bituminous Material".

2.3 ASPHALTS

- A. Comply with provisions of Asphalt Institute Specification SS2:
1. Asphalt cement: Performance grade 64/22
 2. Prime coat: Cut-back type, grade MC-250
 3. Tack coat: Uniformly emulsified, grade SS-1H
 4. Asphalt Concrete Binder Course: PENNDOT SUPERPAVE, 19 mm and 25 mm.
 5. Asphalt Concrete Wearing Course: PENNDOT SUPERPAVE, 9.5 mm.

2.4 GEOTEXTILE

- A. Non-woven Class 4 separation geotextile conforming to PennDot Publication 408/2003, Editing Section 735.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, and protection shall conform to the requirements of the appropriate sections of the PennDot Specifications for the type of material specified.

3.2 MIXING ASPHALTIC CONCRETE MATERIALS

- A. Provide hot plant-mixed asphaltic concrete paving materials.
1. Temperature leaving the plant: 143 degrees C (290 degrees F) minimum, 160 degrees C (320 degrees F) maximum.
 2. Temperature at time of placing: 138 degrees C (280 degrees F) minimum.

3.3 SUBGRADE

- A. Shape to line and grade and compact with self-propelled rollers.
- B. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.

- C. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.
- D. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.
- E. Proof-roll the subgrade with maximum 45 tonne (50 ton) gross weight dump truck as directed by VA Resident Engineer or VA Contracting Officer. If pumping, pushing, or other movement is observed, rework the area to provide a stable and compacted subgrade.

3.4 BASE COURSES

- A. Separation Geotextile:
 - 1. Install Class #4 Separation Geotextile over compacted Subgrade.
Install in strict compliance with material and methods as stipulated in PennDot Publication 408 current edition, Section 735.
- B. Crushed Stone Base Course: For roadways and parking areas.
 - 1. Spread and compact to the thickness shown on the drawings. The stone base course shall be constructed of 10 inches final compacted thickness of crushed limestone aggregate (AASHTO #1) placed in 1 lift, and choked with AASHTO #2A crushed limestone aggregate.
 - 2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
 - 3. After completion of the base rolling there shall be no hauling over the base other than the delivery of material for the top course.
- C. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 0.0mm (0.0") to plus 12.7mm (0.5").
- D. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 5mm in 3m (3/16 inch in ten feet).
- E. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

3.5 PLACEMENT OF ASPHALTIC CONCRETE PAVING

- A. Remove all loose materials from the compacted base.
- B. Receipt of asphaltic concrete materials:
 - 1. Do not accept material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 130 degrees C (280 degrees F).
 - 2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 10 degrees C (50 degrees F), not during fog, rain, or other unsuitable conditions.
- C. Spreading:
 - 1. Spread material in a manner that requires the least handling.
 - 2. Where thickness of finished paving will be 76mm (3") or less, spread in one layer.

D. Rolling:

1. After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown on the drawings.
 - a. Final Compacted Thickness: Asphalt Wear Courses = 38 mm (1-1/2 inches).
 - b. Final Compacted Thickness: asphalt Binder Course = 114 mm (4-1/2 inches).
2. Roll in at least two directions until no roller marks are visible.
3. Finished paving smoothness tolerance:
 - a. No depressions which will retain standing water.
 - b. No deviation greater than 3mm in 1.8m (1/8" in six feet).

3.6 PROTECTION

- A. Protect the asphaltic concrete paved areas from traffic until the sealer is set and cured and does not pick up under foot or wheeled traffic.

3.7 FINAL CLEAN-UP

- A. Remove all debris, rubbish, and excess material from the work area.

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SECTION 32 17 23
PAVEMENT MARKINGS**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This work shall consist of furnishing and applying paint on pavement surfaces, in the form of traffic lanes, parking bays, areas restricted to handicapped persons, crosswalks, and other detail pavement markings, in accordance with the details as shown or as prescribed by the Resident Engineer. Conform to the Manual on Uniform Traffic Control Devices for Streets and Highways, published by the U.S. Department of Transportation, Federal Highway Administration, for details not shown.

1.2 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish Manufacturer's Certificates and Data certifying that the following materials conform to the requirements specified.
- B. Paint.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
TT-P-1952D.....Paint, Traffic Black, and Airfield Marking,
Waterborne
- C. Master Painters Institute (MPI):
No. 97-2007.....Latex Traffic Marking Paint

PART 2 - PRODUCTS**2.1 PAINT**

- A. Paint for marking pavement (parking lot and zone marking) shall conform to MPI No. 97, color as shown. Paint for obliterating existing markings shall conform to Fed. Spec. TT-P-1952D. Paint shall be in containers of at least 18 L (5 gallons). A certificate shall accompany each batch of paint stating compliance with the applicable publication.

2.2 PAINT APPLICATOR

- A. Apply all marking by approved mechanical equipment. The equipment shall provide constant agitation of paint and travel at controlled speeds. Synchronize one or more paint "guns" to automatically begin and cut off paint flow in the case of skip lines. The equipment shall have manual control to apply continuous lines of varying length and marking widths as shown. Provide pneumatic spray guns for hand application of paint in

areas where a mobile paint applicator cannot be used. An experienced technician that is thoroughly familiar with equipment, materials, and marking layouts shall control all painting equipment and operations.

2.3 SANDBLASTING EQUIPMENT

- A. Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall furnish not less than 0.08 m³/s (150 cfm) of air at a pressure of not less than 625 kPa (90 psi) at each nozzle used.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Thoroughly clean all surfaces to be marked before application of paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement with scrapers, wire brushings, sandblasting, mechanical abrasion, or approved chemicals as directed by the Resident Engineer. The application of paint conforming to Fed. Spec. TT-P-1952 is an option to removal of existing paint markings on asphalt pavement. Apply the black paint in as many coats as necessary to completely obliterate the existing markings. Where oil or grease are present on old pavements to be marked, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application. After cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint. Pavement marking shall follow as closely as practicable after the surface has been cleaned and dried, but do not begin any marking until the Resident Engineer has inspected the surface and gives permission to proceed. The Contractor shall establish control points for marking and provide templates to control paint application by type and color at necessary intervals. The Contractor is responsible to preserve and apply marking in conformance with the established control points.

3.2 APPLICATION

- A. Apply uniformly painted pavement marking of required color(s), length, and width with true, sharp edges and ends on properly cured, prepared, and dried surfaces in conformance with the details as shown and established control points. The length and width of lines shall conform

within a tolerance of plus or minus 75 mm (3 inches) and plus or minus 3 mm (1/8 inch), respectively, in the case of skip markings. The length of intervals shall not exceed the line length tolerance. Temperature of the surface to be painted and the atmosphere shall be above 10°C (50°F) and less than 35°C (95°F). Apply the paint at a wet film thickness of 0.4 mm (0.015 inch). Apply paint in one coat. At the direction of the Resident Engineer, markings showing light spots may receive additional coats. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of asphalt, and pick-up, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the marking, discontinue paint operations until cause of the slow drying is determined and corrected. Remove and replace marking that is applied at less than minimum material rates; deviates from true alignment; exceeds stipulated length and width tolerances; or shows light spots, smears, or other deficiencies or irregularities. Use carefully controlled sand blasting, approved grinding equipment, or other approved method to remove marking so that the surface to which the marking was applied will not be damaged.

3.3 PROTECTION

- A. Conduct operations in such a manner that necessary traffic can move without hindrance. Protect the newly painted markings so that, insofar as possible, the tires of passing vehicles will not pick up paint. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic. Efface and replace damaged portions of markings at no additional cost to the Government.

3.4 DETAIL PAVEMENT MARKING

- A. Use Detail Pavement Markings, exclusive of actual traffic lane marking, at exit and entrance islands and turnouts, on curbs, at crosswalks, at parking bays, and at such other locations as shown. Show the International Handicapped Symbol at indicated parking spaces. Color shall be as shown. Apply paint for the symbol using a suitable template that will provide a pavement marking with true, sharp edges and ends. / Place detail pavement markings of the color(s), width(s) and length(s), and design pattern at the locations shown.

3.5 TEMPORARY PAVEMENT MARKING

- A. When shown or directed by the Resident Engineer, apply Temporary Pavement Markings of the color(s), width(s) and length(s) shown or

directed. After the temporary marking has served its purpose and when so ordered by the Resident Engineer, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that the surface to which the marking was applied will not be damaged. As an option, an approved preformed pressure sensitive, reflective, adhesive tape type of temporary pavement marking of the required color(s), width(s) and length(s) may be furnished and used in lieu of temporary painted and reflective marking. The Contractor shall be fully responsible for the continued durability and effectiveness of such marking during the period for which its use is required. Remove any unsatisfactory tape type marking and replace with painted markings at no additional cost to the Government.

3.6 FINAL CLEAN-UP

- A. Remove all debris, rubbish and excess material from the Station.

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SECTION 32 31 10
FENCES AND GATES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This work consists of all labor, materials, and equipment necessary for furnishing and installing in conformance with the lines, grades, and details as shown; the following:
1. Chain link fence and accessories.
 2. Ornamental picket cantilever electrically-operated slide crash gate.

1.2 RELATED WORK

- A. Grounding of fencing for enclosures of electrical equipment and for lightning protection as shown: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- B. Temporary Construction Fence: Section 01 00 00, GENERAL REQUIREMENTS.
- C. Finish Grading: Section 31 20 00, EARTH MOVING, and Section 32 90 00, PLANTING.
- D. Guard Booth: Section 13 34 29, PREFABRICATED GUARD BOOTH.
- E. Electrical Power Requirements: Division 26 Sections.
- F. Card readers and biometric devices: Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEMS

1.3 MANUFACTURER'S QUALIFICATIONS

- A. Fence, gates, and accessories shall be products of manufacturers' regularly engaged in manufacturing items of type specified.

1.4 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES, furnish the following:
1. Manufacturer's Literature and Data: Chain link fencing, gates and all accessories.
 2. Manufacturer's Certificates: Zinc-coating complies with specifications.
- B. Shop Drawings for fences and gates.
- C. Certification that fence alignment meets requirements of contract documents.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
- A392-07.....Zinc-Coated Steel Chain-Link Fence Fabric
 - C94/C94M-07.....Ready-Mixed Concrete
 - F567-07.....Installation of Chain-Link Fence
 - F626-(R2003).....Fence Fittings
 - F900-05.....Industrial and Commercial Swing Gates
 - F1043-06.....Strength and Protective Coatings on Metal
Industrial Chain-Link Fence Framework
 - F1083-08.....Pipe, Steel, Hot-Dipped Zinc-Coated
(Galvanized) Welded, for Fence Structures.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Basis-Of-Design Product: Subject to compliance with requirements, provide Anchor Fence, Division, Master-Halco, Inc. or comparable products from one of the following:
1. Allied Tube and Conduit Corp.
 2. American Fence Corp.
 3. Boundary Fence & Railing Systems, Inc.
 4. Merchant Metals.
 5. Security Fence Manufacturing & Supply Co., Inc.

2.2 GENERAL - CHAIN LINK FENCE

- A. Materials shall conform to ASTM F1083 and ASTM A392 ferrous metals, zinc-coated; and detailed specifications forming the various parts thereto; and other requirements specified herein. Zinc-coat metal members (including fabric, gates, posts, rails, hardware and other ferrous metal items) after fabrication shall be reasonably free of excessive roughness, blisters and sal-ammoniac spots.

2.3 CHAIN-LINK FABRIC

- A. ASTM A392 9 gauge wire woven in a 50 mm (2 inch) mesh. Top and bottom selvage shall have twisted and barbed finish. Zinc-coating weight shall be 2.0 ounces per square foot.
- B. Height shall be 8 feet along property line. Two-inch clearance at ground line. Minimum 7 mil polyvinyl chloride (PVC) plastic resin

finish over galvanized steel wire. Color: Black, refer to Section 09 06 00, Schedule of Finishes.

2.4 POST, FOR GATES AND FENCING

- A. ASTM F1083, Grade SK-40A, round, zinc-coated steel. Dimensions and weights of posts shall conform to the tables in the ASTM Specification. Provide post braces and truss rods for each gate, corner, pull or end post. Provide truss rods with turnbuckles or other equivalent provisions for adjustment.
- B. Line posts shall be 2-1/2 inches O.D.; corner posts shall be 3 inches O.D.; gate posts shall be 4 inches O.D., 6 inches O.D. for swing gates at dumpster enclosures. Height shall be sufficient to accommodate fabric height and ground clearance. Steel Framework Finish: Provide framework and all exposed fittings and accessories in accordance with manufacturer's standard thermally bonded polyvinyl chloride (PVC) plastic resin finish over galvanizing, not less than 10 mils (0.010 inch) thick. Color to match chain link fabric.

2.5 TOP RAIL AND BOTTOM RAIL

- A. ASTM F1083, Grade SK-40A, round, 1-5/8 inch outside diameter, zinc-coated steel. Dimensions and weights of posts shall conform to the tables in the ASTM Specification; fitted with suitable expansion sleeves and means for securing rail to each gate, corner, and end posts.
- B. Steel Framework Finish: Provide framework and all exposed fittings and accessories in accordance with manufacturer's standard thermally bonded polyvinyl chloride (PVC) plastic resin finish over galvanizing, not less than 10 mils (0.010 inch) thick. Color to match chain link fabric.

2.6 ACCESSORIES

- A. Accessories as necessary caps, rail and brace ends, wire ties or clips, braces and tension bands, tension bars, truss rods, and miscellaneous accessories conforming to ASTM F626.

2.7 ORNAMENTAL PICKET CANTILEVER SLIDE GATE CRASH GATE

- A. Gate frames:
 - 1. Fabricate cantilever slide gate top frame using (2) 2" (50 mm) square aluminum members, ASTM B 221, alloy and temper 6063-T6, weighing 1.88 lb/ft (2.78 kg/m).
 - 2. Weld members together forming rigid one-piece frame integral with top track (no substitution).

3. Provide 2 truck assemblies for each gate leaf.
4. Bottom rail 2" x 4" (50 mm x 100 mm) aluminum member weighing 1.71 lb/ft (2.54 kg/m).
5. Gates over 27' (8230 mm) in single opening shall be shipped in 2 parts and field spliced with special attachments provided by the manufacturer.
6. For gates over 15'-0" Opening:
 - a. Internal uprights: 1" x 2" (25 mm x 50 mm) aluminum members welded in gate frames at maximum 6'-2" (1880 mm) face-to-face, subdividing frame into panels. Gates under 15'-0" will have two equal panels.
 - b.

<u>Gate Actual Opening Sizes</u>	<u>Cantilever Support (Overhang)</u>
12 ft (3658mm)	10'-0" (3038mm)
14 ft (4267mm) to 24 ft (7315mm)	12'-0" (3658mm)

B. Ornamental picket Infill:

1. "U" channel rails formed aluminum, 1-3/8" (35 mm) wide x 1-1/2" (38 mm) deep, 11 gauge [0.120" (3.05 mm)] wall thickness.
2. Punch rails to receive pickets and welded inside gate frame.
3. Pickets galvanized steel, [1" (25 mm)] square tube [of gauge, spacing, and with accessories to match fence].
4. Attach pickets to "U" rails by 1/4" (6 mm) industrial drive rivets # MIW 381080691.

C. Bracing: Provide diagonal adjustable length truss rods, of 3/8" (9.5 mm) galvanized steel, in each panel of gate frames.

D. Top track/rail: Enclosed, combination one-piece track and rail, aluminum extrusion with weight of 4.66 lb/ft (6.93 kg/m). Track to withstand reaction load of 2,000 lb (907 kg/m).

E. Truck assembly:

1. Swivel type, zinc die cast, with 10 sealed lubricant ballbearing rollers 2" (50 mm) in diameter by 9/16" (14 mm) in width, and 2 side rolling wheels to ensure truck alignment in track (no substitution).
2. Mount trucks on post brackets using 7/8" (22 mm) diameter ball bolts with 1/2" (13 mm) shank.
3. Design truck assembly to withstand same reaction load as track.

F. Gate hangers, latches, brackets, guide assemblies, and stops: Malleable iron or steel, galvanized after fabrication. Provide positive latch with provisions for padlocking.

- G. Bottom guide wheel assemblies: Each assembly shall consist of two 4" (100 mm) diameter rubber wheels, straddling bottom horizontal gate rail, allowing adjustment to maintain gate frame plumb and in proper alignment. Attach one assembly to each guide post.
- H. Gates posts For crash gate:
1. 2 pair of support post (dual) galvanized steel, 4 inches (100 mm) square, weighing 9.59 lb/ft (14.27 kg/m) each.
 2. Posts connected by welding 6 inch x 3/8 inch (12.7 x 9.5 mm) plate between posts as shown on drawings.
 3. One 4" (100 mm) latch post.
- I. Accessories: Pre-assemble panels with ornamental accessories attached with industrial drive rivets to prevent removal and vandalism.
- J. Finish:
1. After components have been galvanized (inside and out) to provide maximum corrosion resistance, clean and pretreat with phosphate to form amorphous structure on galvanized surface for superior powder coating adhesion.
 2. Give phosphate coated surfaces a thorough water rinse to prepare surface for seal rinse.
 3. Seal rinse with non-chromated solution to improve corrosion resistance and adhesion of finish coat.
 4. Bake metal dry, prior to application of powder coating.
 5. Apply 2.5 mil (0.0635 mm) thickness of polyester resin based powder coating by electrostatic spray process.
 6. Bake finish for 20 minutes (1.2 Ks) at 450°F (232°C), metal temperature.
 7. Color: Black, Refer to SECTION 09 06 00, SCHEDULE OF FINISHES.
- K. 12 inch wide flange beam 53 lb/ft.
- L. 14 inch (356 mm) OD X ½ inch wall thickness bollard filled with reinforced concrete.

2.8 ELECTRIC GATE OPERATION

- A. Gate to be operated by Model XL 1 HP, hydraulic operator and locked utilizing an electric lock with indicating lights. All components of the manual override shall be securely enclosed and locked in a 10 gage steel enclosure, conforming to the following requirements:
1. 1 HP motor, 460 volt - Three Phase.
 2. Operator shall be tested to UL 325 standards and is ETL listed.

3. Limit switches shall be readily adjustable with normal hand tools securely locked in place after adjustment - switch contacts rated 6 amps.
4. Spring-loaded friction feed type drive mechanism, consisting of two drive wheels, a manual toggle-style disconnect to instantly disengage the drive wheels for manual operation.
5. Gate speed shall be 1.2 fps.
6. Drive rail 6061-T6 aluminum, 3/16 inch thick.

2.9 CONCRETE

- A. ASTM C94/C94M, using 19 mm (3/4 inch) maximum-size aggregate, and having minimum compressive strength of 25 mPa (3000 psig) at 28 days. Non-shrinking grout shall consist of one part Portland cement to three parts clean, well-graded sand, non-shrinking grout additive and the minimum amount of water to produce a workable mix.

PART 3 - EXECUTION

3.1 INSTALLATION - CHAIN LINK FENCE

- A. Install fence by properly trained crew, on previously prepared surfaces, to line and grade as shown. Install fence in accordance with ASTM F567 and with the manufacturer's printed installation instructions, except as modified herein or as shown. Maintain all equipment, tools, and machinery while on the project in sufficient quantities and capacities for proper installation of posts, chain links and accessories.
- B. A Registered Professional Land Surveyor or Registered Civil Engineer specified in Section 01 00 00, GENERAL REQUIREMENTS, shall stake out and certify the fence alignment to meet the requirements as shown.

3.2 EXCAVATION

- A. Excavation for concrete-embedded items shall be of the dimensions shown, except in bedrock. If bedrock is encountered before reaching the required depth, continue the excavation to the depth shown or 450 mm (18 inches) into the bedrock, whichever is less, and provide a minimum of 50 mm (2 inches) larger diameter than the outside diameter of the post. Clear loose material from post holes. Grade area around finished concrete footings as shown and dispose of excess earth as directed by the Resident Engineer.

3.3 POST SETTING

- A. Install posts plumb and in alignment. Set post in concrete footings of dimensions as shown, except in bedrock. Thoroughly compact concrete so

as it to be free of voids and finished in a slope or dome to divert water running down the post away from the footing. Straight runs between braced posts shall not exceed 150 m (500 feet). Install posts in bedrock with a minimum of 25 mm (one inch) of non-shrinking grout around each post. Thoroughly work non-shrinking grout into the hole so as to be free of voids and finished in a slope or dome. Cure concrete and grout a minimum of 72 hours before any further work is done on the posts.

3.4 POST SETTING IN STRUCTURES

- A. Install post in retaining walls, curbs, concrete slabs, or similar construction in proper size galvanized pipe sleeves set into the concrete or built into the masonry as shown. Set sleeves plumb and 13 mm (1/2 inch) above the finished structure. Fill space solidly between sleeve and post with non-shrinking grout, molten lead, or sulphur, and finish to divert water running down the post away from the post base.

3.5 POST CAPS

- A. Fit all exposed ends of post with caps. Provide caps that fit snugly and are weathertight. Where top rail is used, provide caps to accommodate the top rail. Install post caps as recommended by the manufacturer and as shown.

3.6 TOP RAILS AND BOTTOM RAILS

- A. Install rails before installing chain link fabric. Provide suitable means for securing rail ends to terminal and intermediate post. Top rails shall pass through intermediate post supporting arms or caps as shown. The rails shall have expansion couplings (rail sleeves) spaced as recommended by the manufacturer. Where fence is located on top of a wall, install expansion couplings over expansion joints in wall.

3.7 ACCESSORIES

- A. Supply accessories (posts braces, tension bands, tension bars, truss rods, and miscellaneous accessories), as required and recommended by the manufacturer, to accommodate the installation of a complete fence, with fabric that is taut and attached properly to posts, rails, and tension wire.

3.8 FABRIC

- A. Pull fabric taut and secured with wire ties or clips to the top rail and bottom rail close to both sides of each post and at intervals of not more than 600 mm (24 inches) on centers. Secure fabric to posts using stretcher bars and ties or clips.

3.9 ORNAMENTAL PICKET CANTILEVER SLIDE GATE CRASH GATE FRAMING INSTALLATION

- A. Install gate post in accordance with manufacturer instructions.
- B. Concrete set gate posts:
 - 1. Drill holes in firm, undistributed or compacted soil.
 - 2. Holes shall have diameter 4 times greater than outside dimension of post, and depths approximately 6" (152 mm) deeper than post bottom.
 - 3. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.
 - 4. Set post bottom 36" (914 mm) below surface when in firm, undisturbed soil.
 - 5. Place concrete around posts in a continuous pour, tamp for consolidation.
 - 6. Trowel finish around post and slope to direct water away from posts.
- C. Gate posts and hardware: Set keepers, stops, sleeves and other accessories into concrete. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

3.10 ORNAMENTAL PICKET CANTILEVER SLIDE GATE CRASH GATE INSTALLATION

- A. Install gates plumb, level, and secure for full opening without interference.
- B. Attach electric gate operator and hardware by means which will prevent unauthorized removal.
- C. Adjust electric gate operator hardware for smooth operation.

3.11 REPAIR OF GALVANIZED SURFACES

- A. Use galvanized repair compound, stick form, or other method, where galvanized surfaces need field or shop repair. Repair surfaces in accordance with the manufacturer's printed directions.

3.12 FINAL CLEAN-UP

- A. Remove all debris, rubbish and excess material from the station.

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SECTION 32 90 00
PLANTING**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This work consists of furnishing and installing all planting materials and benches required for landscaping hereinafter specified in locations as shown.

1.2 EQUIPMENT

- A. Maintain all equipment, tools and machinery while on the project in sufficient quantities and capacity for proper execution of the work.

1.3 RELATED WORK

- A. Section 31 20 00, EARTH MOVING, Stripping Topsoil and Stock Piling.
B. Section 01 45 29, TESTING LABORATORY SERVICES, Topsoil Testing.
C. Section 31 20 00, EARTH MOVING, Topsoil Materials.
D. Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.4 SUBMITTALS

- A. Samples: Submit the following samples for approval before work is started:

Inert Mulch	2.3 kg (5 pounds) of each type to be used.
Organic Mulch	2.3 kg (5 pounds) of each type to be used.
Pre-Emergent Herbicide	2.3 kg (5 pounds) of each type to be used.

- B. Certificates of Conformance or Compliance: Before delivery, notarized certificates attesting that the following materials meet the requirements specified shall be submitted to the Resident Engineer for approval:

1. Plant Materials (Department of Agriculture certification by State Nursery Inspector declaring material to be free from insects and disease).
2. Fertilizers.
3. Lime
4. Peat
5. Seed
6. Membranes
7. Asphalt Adhesive

- C. Manufacturer's Literature and Data:

1. Metal edging
2. Antidesiccant

D. Soil laboratory testing results and any soil amendment recommendations from the Contractor.

E. Benches:

1. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.
2. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.
3. Samples: Submit manufacturer's samples of materials, finishes, and colors.
4. Warranty: Manufacturer's standard warranty.

1.5 DELIVERY AND STORAGE

A. Delivery:

1. Notify the Resident Engineer of the delivery schedule in advance so the plant material may be inspected upon arrival at the job site. Remove unacceptable plant material from the job site immediately.
2. Protect plants during delivery to prevent damage to root balls or desiccation of leaves. Protect trees during transport by tying in the branches and covering all exposed branches.
3. The use of equipment such as "tree spades" is permitted provided the plant balls are sized in accordance with ANSI Z60.1 and tops are protected from damage.
4. Deliver fertilizer and lime to the site in the original, unopened containers bearing the manufacturer's warranted chemical analysis, name, trade name or trademark, and in conformance to state and federal law. In lieu of containers, fertilizer and lime may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.
5. During delivery: Protect sod, from drying out and seed from contamination.

B. Storage:

1. Keep seed, lime, and fertilizer in dry storage away from contaminants.
2. Store plants not installed on the day of arrival at the site as follows:
 - a. Shade and protect plants from the wind when stored outside.
 - b. Heel in bare root plants.

- c. Protect plants stored on the project from drying out at all times by covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss, or other similar mulching material.
- d. Keep plants, including those in containers, in a moist condition until planted, by watering with fine mist spray.

1.6 PLANTING AND TURF INSTALLATION SEASONS AND CONDITIONS

- A. Perform operations within the following dates: From March 1 to June 1 for spring and from August 15 to October 15 for fall.
- B. No work shall be done when the ground is frozen, snow covered, too wet or in an otherwise unsuitable condition for planting. Special conditions may exist that warrants a variance in the specified planting dates or conditions. Submit a written request to the Resident Engineer stating the special conditions and proposal variance.

1.7 PLANT AND TURF ESTABLISHMENT PERIOD

- A. The Establishment Period for plants and turf shall begin immediately after installation, with the approval of the Resident Engineer, and continue until the date that the Government accepts the project or phase for beneficial use and occupancy. During the Plant and Turf Establishment Period the Contractor shall:
 - 1. Water all plants and turf to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of 25 mm (1 inch) of absorbed water per week either through natural rainfall or augmented by periodic watering. Apply water at a moderate rate so as not to displace the mulch or flood the plants and turf.
 - 2. Prune plants and replace mulch as required.
 - 3. Replace and restore stakes, guy wires, and eroded plant saucers as required.
 - 4. In plant beds and saucers, remove grass, weeds, and other undesired vegetation, including the root growth, before they reach a height of 75 mm (3 inches).
 - 5. Spray with approved insecticides and fungicides to control pests and ensure plant survival in a healthy growing condition, as directed by the Resident Engineer.
 - 6. Provide the following turf establishment:
 - a. Eradicate all weeds. Water, fertilize, overseed, and perform any other operation necessary to promote the growth of grass.
 - b. Replant areas void of turf 0.1 m² (one square foot) and larger in area.

- c. Mow the new lawn at least three times prior to the final inspection. Begin mowing when grass is 100 mm (4 inches) high. Mow to a 65 mm (2-1/2 inch) height.
- 7. Remove plants that die during this period and replace each plant with one of the same size and species.

1.8 PLANT AND TURF WARRANTY

- A. All work shall be in accordance with the terms of the Paragraph, "Warranty" of FAR clause 52.246-21, including the following supplements:
 - 1. A One Year Plant and Turf Warranty will begin on the date that the Government accepts the project or phase for beneficial use and occupancy. The Contractor shall have completed, located, and installed all plants and turf according to the plans and specifications. All plants and turf are expected to be living and in a healthy condition at the time of final inspection.
 - 2. The Contractor will replace any dead plant material and any areas void of turf immediately. A one year warranty for the plants and turf that was replaced, will begin on the day the work is completed.
 - 3. Replacement of relocated plants, that the Contractor did not supply, is not required unless they die from improper handling and care during transplanting. Loss through Contractor negligence requires replacement in kind and size.
 - 4. The Government will reinspect all plants and turf at the end of the One Year Warranty. The Contractor will replace any dead, missing, or defective plant material and turf immediately. The Warranty will end on the date of this inspection provided the Contractor has complied with the work required by this specification. The Contractor shall also comply with the following requirements:
 - a. Replace dead, missing or defective plant material prior to final inspection.
 - b. Mulch and weed plant beds and saucers. Just prior to this inspection, treat these areas to a second application of approved pre-emergent herbicide.
 - c. From plants having been installed for one year, remove stakes, guy wires and any required tree wrappings.
 - d. Complete remedial measures directed by the Resident Engineer to ensure plant and turf survival.
 - e. Repair damage caused while making plant or turf replacements.
- B. Benches: Products will be free from defects in material and/or workmanship for a period of three years from the date of substantial

completion. The warranty does not apply to damage resulting from accident, alteration, misuse, tampering, negligence, or abuse.

1.9 APPLICABLE PUBLICATIONS

- A. The publications listed below, form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American National Standards Institute (ANSI) Publications:
 - ANSI Z60.1-04.....Nursery Stock
 - ANSI Z133.1-06.....Tree Care Operations-Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush- Safety Requirements
- C. Hortus Third, A Concise Dictionary of Plants Cultivated in the U.S. and Canada.
- D. American Society for Testing and Materials (ASTM) Publications:
 - C136-06.....Sieve Analysis of Fine and Coarse Aggregates
 - D977-05.....Emulsified Asphalt (AASHTO M140)
 - D2103-05.....Polyethylene Film and Sheeting
- E. U. S. Department of Agriculture Federal Seed Act.
 - 1998.....Rules and Regulations
- F. American Wood Protection Association (AWPA):
 - C2-02.....Lumber, Timbers, Bridge Ties and Mine Ties, Pressure Treatment

PART 2 - PRODUCTS

2.1 GENERAL

- A. All plant and turf material will conform to the varieties specified or shown in the plant list and be true to botanical name as listed in Hortus Third.

2.2 PLANTS

- A. Plants shall be in accordance with ANSI Z60.1, except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specification shall prevail.
- B. Provide well-branched and formed planting stock, sound, vigorous, and free from disease, sunscald, windburn, abrasion, harmful insects or insect eggs with healthy, normal, and unbroken root systems. Provide trees, deciduous and evergreen, that are single trunked with a single leader, unless otherwise indicated, display no weak crotches. Provide symmetrically developed deciduous trees and shrubs of uniform habit of growth, with straight boles or stems and free from objectionable

disfigurements, and evergreen trees and shrubs with well developed symmetrical tops with typical spread of branches for each particular species or variety. Provide ground cover and vine plants with the number and length of runners for the size specified, and the proper age for the grade of plants specified. Provide vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections. Plants shall have been grown under climatic conditions similar to those in the locality of the project. Spray all plants budding into leaf or having soft growth with an anti-desiccant at the nursery before digging.

- C. The minimum acceptable sizes of all plants, measured before pruning with branches in normal position, shall conform to the measurements designated. Plants larger in size than specified may be used with the approval of the Resident Engineer, with no change in the contract price. When larger plants are used, increase the ball of earth or spread of roots in accordance with ANSI Z60.1.
- D. Provide nursery grown plant material conforming to the requirements and recommendations of ANSI Z60.1. Dig and prepare plants for shipment in a manner that will not cause damage to branches, shape, and future development after planting.
- E. Balled and burlapped (B&B) plant ball sizes and ratios will conform to ANSI Z60.1, consisting of firm, natural balls of soil wrapped firmly with burlap or strong cloth and tied.
- F. Bare-root (BR) plants shall have the root system substantially intact, but with the earth carefully removed. Cover roots with a thick coating of mud by "puddling" after the plants are dug.
- G. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers, but shall not be root bound.
- H. Make substitutions only when a plant (or its alternates as specified) is not obtainable and the Resident Engineer authorizes a change order providing for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of the contract price.
- I. When existing plants are to be relocated, ball sizes shall conform to requirements for collected plants in ANSI Z60.1, and plants shall be dug, handled, and replanted in accordance with applicable sections of these specifications.

2.3 LABELS

- A. Each plant, or group and bundles or containers of the same species, variety, and size of plant, shall be legibly tagged with a durable,

waterproof and weather-resistant label indicating the correct plant name and size specified in the plant list. Labels shall be securely attached and not be removed.

2.4 TOPSOIL

- A. Topsoil shall be a well-graded soil of good uniform quality. It shall be a natural, friable soil representative of productive soils in the vicinity. Topsoil shall be free of admixture of subsoil, foreign matter, objects larger than 25 mm (one inch) in any dimension, toxic substances, weeds and any material or substances that may be harmful to plant growth and shall have a pH value of not less than 5.0 nor more than 7.5.
- B. Sufficient topsoil is not available on the site to meet the depth as specified herein. The Contractor shall furnish additional topsoil. At least 10 days prior to topsoil delivery, notify the Resident Engineer of the source(s) from which topsoil is to be furnished. Obtain topsoil from well drained areas. Topsoil shall meet the general requirements as stated above and comply with the requirements specified in Section 01 45 29, TESTING LABORATORY SERVICES. Amend topsoil not meeting the pH range specified by the addition of pH adjusters.

2.5 LIME

- A. Lime shall be agricultural limestone containing not less than 90 percent calcium and magnesium carbonates. Lime must be ground to such a fineness that not less than 90% must pass No. 8 mesh and not less than 25% must pass No. 100 mesh. Moisture is not to exceed 10%.

2.6 SOIL CONDITIONERS

- A. Peat shall be a natural product of sphagnum moss peat derived from a fresh-water site conforming to Fed. Spec. Q-P-166, except as otherwise specified. Peat shall be shredded and granulated to pass through a 13 mm (1/2inch) mesh screen and conditioned in storage piles for at least six months after excavation.
- B. Organic Matter shall be commercially prepared compost, composted sufficiently to be free of all woody fibers, seeds, and leaf structures, and free of toxic and nonorganic matter.
- C. Fertilizer: Agricultural fertilizer of a formula indicated by the soil test. Fertilizers shall be organic, slow-release compositions whenever applicable

2.7 PLANTING SOIL MIXTURE

- A. The planting soil mixture shall be composed of 5 parts topsoil, and 1/2 part peat moss and 1/2 part organic matter.

2.8 PLANT FERTILIZER

- A. Provide plant fertilizer that is commercial grade and uniform in composition and conforms to applicable state and federal regulations.
- B. For new plant material, provide packet, table, or pellet forms of slow release fertilizers, bearing the manufacturer's warranted statement of analysis. Slow release fertilizers shall contain a minimum percentage by weight of 10 percent nitrogen (of which 50 percent will be organic), 10 percent available phosphoric acid, and 10 percent potash.

2.9 TURF FERTILIZER

- A. Provide turf fertilizer that is commercial grade, free flowing, uniform in composition, and conforms to applicable state and federal regulations. Granular fertilizer shall bear the manufacturer's warranted statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of 20 percent nitrogen (of which 50 percent shall be organic), 10 percent available phosphoric acid, and 10 percent potash. Liquid starter fertilizer for use in the hydro seed slurry will be commercial type with 50 percent of the nitrogen in slow release form.

2.10 MEMBRANES

- A. Landscape Fabric shall be a spunbonded polyester fabric weighing 18 grams per square meter ($\frac{3}{4}$ oz per sq. yd) and with a 9,000 liter per minute flow rate per sq. meter (225 gal. per minute flow rate per sq. ft.).

2.11 MULCH

- A. Mulch shall be free from deleterious materials and shall be stored as to prevent inclusion of foreign material.
- B. Inert mulch materials shall be riverbank stone and shall range in size from 25 mm (one inch) to 65 mm (2-1/2 inches) in accordance with ASTM C 136.
- C. Organic mulch materials shall be straw shredded hardwood bark
 - 1. Straw for lawn seed bed mulch shall be stalks from oats, wheat, rye, barley, or rice that are free from noxious weeds, mold or other objectionable material. Straw shall be in an air-dry condition and suitable for placing with blower equipment.
or applied water to percolate to the underlaying soil.

2.12 ASPHALT ADHESIVE

- A. Asphalt adhesive for application with straw mulch shall be emulsified asphalt conforming to ASTM D977, Grade RS-1.

2.13 TREE WRAP

- A. Extruded, translucent, twin-walled polypropylene protection board sheets; 3 mm thick. 1800mm (6 ft) long tree shelters may be utilized for

short trunk trees 75 mm (3 in.) caliper or less. Submit manufacturer literature for approval. C. Breathable synthetic fabric tree wrap. White in color, delivered in 75 mm (3 in.) wide rolls. Specifically manufactured for tree wrapping. Tree wrap shall be "Breathable Fabric Tree Wrap" as manufactured by the Dewitt Company, Inc., Sikeston, MO, or approved equal. Submit manufacturer literature for approval.

- B. Tree wrap shall be secured to the trunk using bio-degradable tape suitable for nursery use and which is expected to degrade in sunlight in less than two years after installation

2.14 STAKES AND GUYING WIRES

- A. Provide stakes for tree support of rough sawn wood, free from knots, rot, cross grain, or other defects that would impair the strength. Stakes shall be a minimum of 50 mm by 50 mm (2 inches by 2 inches), or 65 mm (2-1/2 inches) in diameter, by 2400 mm (8 feet) long and pointed at one end.
- B. Guying wire shall be 2.7 mm (12 gage) annealed galvanized steel.
- C. Hose chafing guards shall be new or used 2-ply reinforced rubber of all the same color on the project.
- D. Flags to be fastened to guys shall be surveyor's plastic tape, yellow in color and 150 mm (6 inches) in length.
- E. Guying cable shall be a minimum of five strand twisted, 5 mm (3/16 inch) diameter steel cable.
- F. Turnbuckles shall be galvanized or cadmium plated and have a 75 mm (3 inch) minimum lengthwise opening fitted with screw eyes.
- G. Eye bolts shall be galvanized or cadmium plated having a 50 mm (one inch) diameter eye with a minimum screw length of 40 mm (1-1/2 inches).

2.15 EDGING

- A. Metal edging shall be galvanized steel or aluminum with slots provided for stakes and shall be 5 mm (3/16 inch) thick by zero inches) deep in standard lengths. Anchoring stakes shall be of similar material and 400 to 450 mm (16 to 18 inches) long and tapered.

2.16 WATER

- A. Water shall not contain elements toxic to plant life. It shall be obtained from Government at no cost to Contractor in accordance with Article 1.19 Availability and Use of Utility Services Section 01 00 00, GENERAL REQUIREMENTS.

2.17 ANTIDESICCANT

- A. Antidesiccant shall be an emulsion specifically manufactured for agricultural use that will provide a protective film over plant surfaces permeable enough to permit transpiration.

2.18 SEED

- A. Seed shall be state-certified seed of the latest season's crop and shall be delivered in original sealed packages bearing the producer's warranted analysis for percentages of mixtures, purity, germination, weed seed content, and inert material. Seed shall be labeled in conformance with U. S. Department of Agriculture rules and regulations under the Federal Seed Act and applicable state seed laws. Seed that has become wet, moldy, or otherwise damaged will not be acceptable. Onsite seed mixing shall be done only in the presence of the Resident Engineer. Seed mixtures shall be proportioned by weight as follows:

NAME OF GRASS

(Botanical and Common)	<u>Percent by Weight</u>
Poa pratensis (Kentucky Bluegrass)	50
Festuca cubra (Red Fescue)	30
Lolium perenne (Turf-type Perennial Ryegrass)	20
<hr/>	
<u>Percent Germination</u>	<u>Maximum Percent Weed Seed</u>
80	0.20
85	0.15
90	0.15
<hr/>	

2.19 BENCHES

- A. Manufacturer: Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, Michigan 49048. Toll Free (800) 521-2546. Phone (269) 381-0396. Fax (269) 381-3455. Website www.landscapeforms.com. E-mail: specify@landscapeforms.com; or equivalent.
- B. Type: Sit.
- C. Style:
1. Backed:
 - a. Depth: 24-3/4 inches.
 - b. Overall Height: 32-1/4 inches.
 - c. Length: 74 inches.
 2. Mounting: Surface mounted.
- D. Supports: End supports are type 319 ASTM B 26 aluminum sand casting.
- E. Frame: Seat rails are 1/5" outer diameter x 0.120" wall ASTM A 513 type 1 steel tubing with type 304 ASTM A 276 stainless steel threaded inserts welded inside each end. Seat panel connections are 0.250" x 0.75" x

0.80" type 304 ASTM A 276 stainless steel flat bar welded to rail.

Upper and lower back rails are 6061-T6 or 6005A-T5 ASTM B 211 aluminum extrusions. Upper rail is 1.375" diameter; lower rail is 0.875" diameter.

- F. Seat and Back Panels: Seat panel is 0.120" thick ASTM A 1011 hot rolled pickled and oiled commercial steel type B perforated and formed. Seat panel connections are 0.188" x 1" x 1.5" type 304 ASTM A 276 stainless steel flat bar welded to panel. Back and side panels are 0.125" thick 3003-H14 ASTM B 209 aluminum sheet perforated and formed. Back panel is welded to back rails; side panels are welded to end castings.
- G. Surface Mount Plates: 0.375" thick 6061-T6511 ASTM B 221 aluminum flat bar.
- H. Fasteners: All threaded fasteners are stainless steel or Magni 565 coated carbon steel. Seat dividers are attached with nylon shoulder and flat washers to protect the seat panel finish.
- I. Anchor Bolts: Manufacturer's recommended corrosion resistant.
- J. Finish on Metal: Landscape Forms, Inc. "Pangard II".
 - 1. Primer: Rust inhibitor.
 - 2. Topcoat: Thermosetting polyester powder coat. UV, chip, and flake resistant.

PART 3 - EXECUTION

3.1 LAYOUT

- A. Stake plant material locations and bed outlines on project site for approval by the Resident Engineer before any plant pits or beds are dug. The Resident Engineer may approve adjustments to plant material locations to meet field conditions.

3.2 EXCAVATION FOR PLANTING

- A. Prior to excavating for plant pits and bed, verify the location of any underground utilities. Damage to utility lines will be repaired at the Contractor's expense. Where lawns have been established prior to planting operation, cover the surrounding turf before excavations are made in a manner that will protect turf areas. Barricade existing trees, shrubbery, and beds that are to be preserved in a manner that will effectively protect them during the project construction.
- B. Remove rocks and other underground obstructions to a depth necessary to permit proper planting according to plans and specifications. Where underground utilities, construction, or solid rock ledges are encountered, the Resident Engineer may select other locations for plant material.

- C. Dig plant pits by any approved method so that they have vertical sides and flat bottoms. When pits are dug with an auger and the sides of the pits become glazed, scarify the glazed surface. Size the plant pits as shown, otherwise, the minimum allowable dimensions of plant pits shall be regardless of width, 150 mm (6 inches) deeper for shrubs for trees - pits shall be the same depth as the depth of ball or root spread for trees and shrubs pit diameters shall be twice the ball or root spread.
- D. Where ground cover and planting beds occur in existing turf areas, remove turf to a depth that will ensure the removal of the entire root system, with additional bed preparation as specified in the next paragraph.
- E. Where existing soil is to be used in place, till new ground cover and plant beds to a depth of 100 mm (4 inches). Spread peat uniformly over the bed to depth of 50 mm (2 inches) and thoroughly incorporate it into the existing soil to a depth of 100 mm (4 inches) using a roto-tiller or similar type of equipment to obtain a uniform and well pulverized soil mix. Where existing soil is compacted (former roadways, parking lots, etc.) till the soil down to a depth necessary to support the growth of new planting. During tillage operations, remove all sticks, stones, roots, and other objectionable materials. Bring plant beds to a smooth and even surface conforming to established grades.
- F. In areas of new grading where existing soil is being replaced for the construction of new ground cover and plant beds, remove 100 mm (4 inches) of existing soil and replace with topsoil. Plant beds shall be brought to a smooth and even surface conforming to established grades. Till 50 mm (2 inches) of peat into the topsoil as specified.
- G. Using topsoil, form earth saucers or water basins for watering around plants. Basins to be 2" high for shrubs and 4" high for trees.

3.3 SETTING PLANTS

- A. Handle balled and burlapped and container-grown plants only by the ball or container. Remove container-grown plants in such a way to prevent damage to plants or root system. Set plants plumb and hold in position until sufficient soil has been firmly placed around the roots or ball. Set plants so that the root crown is 1" higher than the surrounding grade. Plant ground cover plants after the mulch is in place. Avoid contaminating the mulch with the planting soil. Add slow release packet, tablet or pellet fertilizer as each plant is installed as per manufacturer's recommendation for method of installation and quantity.
- B. Backfill balled and burlapped and container-grown plants with planting soil mixture as specified to approximately half the depth of the ball

and then tamp and water. For balled and burlapped plants, carefully remove excess burlap and tying materials and fold back. Where plastic wrap or treated burlap is used in lieu of burlap, completely remove these materials before backfilling. Tamp and water remainder of backfill Planting Soil Mixture; then form earth saucers or water basins around isolated plants with topsoil.

- C. Plant bare-root stock arranging the roots in a natural position. Remove damaged roots with a clean cut. Carefully work Planting Soil Mixture in among the roots. Tamp and water the remainder of Planting Soil Mixture; then form earth saucers or water basins around isolated plants with topsoil.

3.4 TRUNK WRAPPING

- A. Wrap the trunks of deciduous trees immediately after planting. Wrap the trunks of deciduous trees, 40 mm (1-1/2 inches) or greater in caliber with the specified material beginning at the base and extending to the first branches. Remove wrapping after one year. .

3.5 STAKING AND GUYING

- A. Stake and guy plants as shown on the drawings and as specified.
- B. Drive stakes vertically into the ground to a depth of 800 to 900 mm (2-1/2 to 3 feet) in such a manner as not to injure the ball or roots, unless otherwise shown on the drawings.
- C. Fasten flags securely on each guy wire.
- D. Remove stakes and guy wires after one year.

3.6 EDGING PLANT BEDS

- A. Uniformly edge beds using a sharp tool to provide a clear cut division line between the planted area and the adjacent lawn.
- B. Install metal edging materials in accordance with manufacturer's recommendations and as shown on the plans.

3.7 MULCHING PLANTS

- A. Mulch within 48 hours after planting and applying a pre-emergent herbicide. Do not mulch in ground cover areas that shall have organic material placed before planting.
- B. Placing Inert Material: Place Landscape fabric with edges lapped 150 mm to 300 mm (6 inches to 12 inches) to receive inert mulch material. Spread inert mulch to a uniform thickness of 4 inches over the membrane or as shown.
- C. Placing Organic Material: Spread a mulch of shredded hardwood bark to a uniform minimum thickness of 100 mm (4 inches).
- D. Keep mulch out of the crowns of shrubs and off buildings, sidewalks, light standards, and other structures.

3.8 PRUNING

- A. Prune new plant material and indicated existing plant material in the following manner: Remove dead, broken and crossing branches. Prune deciduous trees and shrubs to reduce total amount of anticipated foliage by 1/4 to 1/3 while retaining typical growth habit of individual plants with as much height and spread as is practicable. Make cuts with sharp instruments as close as possible to the branch collar. Do not make flush cuts. Do not make "Headback" cuts at right angles to line of growth. Do not pole trees or remove the leader. Remove trimmings from the site. Paint cuts 13 mm (1/2 inch) in diameter and larger with the specified tree wound dressing.

3.9 TILLAGE FOR TURF AND PLANTING AREAS

- A. Thoroughly till the soil to a depth of at least 200 mm (8 inches) by scarifying, disking, harrowing, or other approved methods. This is particularly important in areas where heavy equipment has been used, and especially under wet soil conditions. Remove all debris and stones larger than 25 mm (one inch) remaining on the surface after tillage in preparation for finish grading. To minimize erosion, do not till areas of 3:1 slope ratio or greater. Scarify these areas to a 50 mm (one inch) depth and remove debris and stones.

3.10 FINISH GRADING

- A. After tilling the soil for bonding of topsoil with the subsoil, spread the topsoil evenly to a minimum depth of 150 mm (6 inches). Incorporate topsoil at least 50 to 75 mm (2 to 3 inches) into the subsoil to avoid soil layering. Do not spread topsoil when frozen or excessively wet or dry. Correct irregularities in finished surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic. Complete lawn work only after areas are brought to finished grade.

3.11 APPLICATION OF FERTILIZER AND LIME FOR TURF AREAS

- A. Apply nitrogen turf fertilizer at the rate of 2.2 kg/100 m² (1 pound per 1,000 square feet). In addition, adjust soil acidity and add soil conditioners as required herein for suitable topsoil under PART 2, Paragraph, TOPSOIL.
- B. Spread lime at the rate of 88 kg/100 m² (40 pounds per 1,000 square feet).
- C. Incorporate fertilizers and lime into the soil to a depth of at least 50 mm (2 inches) as part of the finish grading operation. Immediately restore the soil to an even condition before any turf work.

3.12 MECHANICAL SEEDING

- A. Broadcast seed by approved sowing equipment at the rate of 6.6 kg/100 m² (3 pounds per 1,000 square feet). Sow one half of the seed in one direction, and the remainder sown at right angles to the first sowing. Cover seed to an average depth of 6 mm (1/4 inch) by means of spike-tooth harrow, cultipacker, or other approved device.
- B. Immediately after seeding, firm up the entire area with a roller not exceeding 225 kg/m (150 pounds per foot) of roller width. Where seeding is performed with a cultipacker-type seeder or where seed is applied in combination with hydro-mulching, no rolling is required.
- C. Immediately after preparing the seeded area, evenly spread an organic mulch of straw by hand or by approved mechanical blowers at the rate of 0.5 kg/m² (2 tons per acre). Application shall allow some sunlight to penetrate and air to circulate but also reduce soil and seed erosion and conserve soil moisture. Anchor mulch by either a mulch tiller, asphalt emulsion, twine, or netting. When asphalt emulsion is used, apply either simultaneously or in a separate application. Take precautionary measures to prevent asphalt materials from marking or defacing structures, pavements, utilities, or plantings.

3.13 WATERING

- A. Apply water to the turf areas immediately following installation at a rate sufficient to ensure thorough wetting of the soil to a depth of at least 100 mm (4 inches). Supervise watering operation to prevent run-off. Supply all pumps, hoses, pipelines, and sprinkling equipment. Repair all areas damaged by water operations.

3.14 PROTECTION OF TURF AREAS

- A. Immediately after installation of the turf areas, protect against traffic or other use by erecting barricades, as required, and placing approved signs at appropriate intervals until final acceptance.

3.15 RESTORATION AND CLEAN-UP

- A. Where existing or new turf areas have been damaged or scarred during planting and construction operations, restore disturbed area to their original condition. Keep at least one paved pedestrian access route and one paved vehicular access route to each building clean at all times. In areas where planting and turf work have been completed, clear the area of all debris, spoil piles, and containers. Clear all other paved areas when work in adjacent areas is completed. Remove all debris, rubbish and excess material from the station.

3.16 ENVIRONMENTAL PROTECTION

- A. All work and Contractor operations shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

3.17 INSTALLATION OF BENCHES

- A. Install benches in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Install benches level.
- C. Anchor benches securely in place.
- D. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions.
- E. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Resident Engineer.
- F. Clean benches promptly after installation in accordance with manufacturer's instructions.
- G. Do not use harsh cleaning materials or methods that could damage finish.
- H. Protect installed benches to ensure that, except for normal weathering, benches will be without damage or deterioration at time of Substantial Completion.

- - - E N D - - -

SECTION 33 30 00
SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Outside, underground sanitary sewer system, complete, ready for operation, including all gravity flow lines manholes, cleanouts, frames, covers, structures, appurtenances, and connections to new building and structure, service lines, existing sanitary sewer lines, and existing sanitary structures, and all other incidentals.

1.2 RELATED WORK:

- A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- C. Concrete Work Reinforcing, Placement and Finishing; Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATIONS.
- E. Protection of Materials and Equipment: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. Sanitary Sewer Pumping Facilities, Division 22, PLUMBING.

1.3 QUALITY ASSURANCE:

- A. Products Criteria:
 - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 - 2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, including model number, securely affixed in a conspicuous place on equipment, or name or trademark, including model number cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Sanitary Sewer lines and the extension, and/or modifications to Public Utility Systems.

1.4 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data: Submit the following as one package:
 - 1. Pipe, Fittings, and, Appurtenances.
 - 2. Jointing Material.
 - 3. Manhole and Structure Material.

4. Frames and Covers.

5. Steps and Ladders.

1.5 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
- A48/A48M-03.....Gray Iron Castings
 - A536-84(2004).....Ductile Iron Castings
 - A615/A615M-06.....Deformed and Plain Carbon-Steel Bars for
Concrete Reinforcement
 - C139-05.....Concrete Masonry Units for Construction of Catch
Basins and Manholes
 - C150-05.....Portland Cement
 - C478-06a/C478M-06a.....Precast Reinforced Concrete Manhole Sections
Underground Precast Concrete Utility Structures
 - D698-00ae1.....Laboratory Compaction Characteristics of Soil
Using Standard Effort (12,400 ft-lbf/ft³ (600
kN-m/m³))
 - D2321-05.....Underground Installation of Thermoplastic Pipes
for Sewers and Other Gravity-Flow Applications
 - D3034-04a.....Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe
and Fittings
 - D3212-07.....Joints for Drain and Sewer Plastic Pipes Using
Flexible Elastomeric Seals
 - F477-02e1.....Elastomeric Seals (Gaskets) for Joining Plastic
Pipe
 - F679-06.....Poly (vinyl chloride) (PVC) Large-Diameter
Plastic Gravity Sewer Pipe and Fittings
- D. American Association of State Highway and Transportation Officials (AASHTO):
- M198-05.....Joints for Concrete Pipe, Manholes, and Precast
Box Sections using Preformed Flexible Joint
Sealants
- E. Uni-Bell PVC Pipe Association:
- Uni-B-6-98.....Recommended Practice Low Pressure Air Testing of
Installed Sewer Pipe

PART 2 - PRODUCTS

2.1 PIPING:

- A. Gravity Flow Lines (Pipe and Fittings):
- 1. Polyvinyl Chloride (PVC):

- a. Pipe and Fittings, 100 to 375 mm (4 to 15 inches) in diameter, shall conform to ASTM D3034, Type PSM, SDR 35, SDR 26. Pipe and fittings shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D3212. Gaskets shall conform to ASTM F477. Solvent welded joints shall not be permitted.
- b. Solid wall pipe and fittings shall conform to ASTM F679, SDR 35, SDR 26 pipe and fittings shall gaskets conforming to ASTM F477, and shall be able to withstand a hydrostatic pressure of 345 kPa (50 psi).

2.2 JOINT MATERIALS

A. Gravity Flow Lines:

1. Polyvinyl Chloride (PVC) Pipe (Gravity Use): Joints, ASTM D3212. Elastomeric Gasket, ASTM F477.

2.3 MANHOLES:

A. Manholes shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. The manholes shall be in accordance with State Department of Transportation or State Roads Commission standard details, and the following:

1. Precast Concrete Segmental Blocks: Blocks shall conform to ASTM C139 and shall not be less than 150 mm (6 inches) thick for manholes to a depth of 3.6m (12 feet); not less than 200 mm (8 inches) thick for manholes deeper than 3.6m (12 feet) deep. Blocks shall be not less than 200 mm (8 inches) in length. Blocks shall be shaped so that joints seal and bond effectively with cement mortar. Parge structure interior and exterior with 15 mm (1/2 inch) of cement mortar applied with a trowel and finished to an even glazed surface.
2. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
3. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
4. Mortar:

- a. Precast Concrete Segmental Block Structures: By volume, 1 part of Portland cement, 1/4 part lime hydrate, and 3 parts sand.
 - b. Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21 L (5-1/2 gallons) per sack of cement.
5. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M198.
 6. Frames and covers shall be gray cast iron conforming to ASTM A48. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover, and the words "sanitary sewer". The studs and the lettering shall be raised 8 mm (5/16 inch). The cover shall be a minimum of 600 mm (24 inches) in diameter and shall have four 19 mm (3/4 inch) vent holes and two lifting slots. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.
 7. Manhole steps shall be polypropylene plastic coated on a No. 4 deformed rebar conforming to ASTM C478, Polypropylene shall conform to ASTM D4101. Steps shall be a minimum of 406 mm (16 inches) wide and project a minimum of 178 mm (7 inches) away from the wall. The top surface of the step shall have a studded non-slip surface. Steps shall be placed at 300 mm (12 inch) centers.
 8. Ladders, brackets and hardware shall be constructed of welded aluminum, rails shall be 10 mm (3/8 inch) by 63 mm (2-1/2 inches) spaced a minimum of 400 mm (16 inches) apart. Rungs shall be 35 mm (1-3/8 inches) in diameter and have a non-slip surface. Standoffs shall offset the ladder 180 mm (7 inches) from the wall. The ladder assembly shall be rated for a minimum of 2200 N (500 pounds).

2.4 CONCRETE:

- A. Concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform with the provisions of Division 03 of these specifications.

2.5 REINFORCING STEEL:

- A. Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.6 CONCRETE PROTECTIVE COATING:

- A. Concrete coating for the interior of wet wells shall consist of an epoxy blended filler sealer, and a cross linked epoxy phenolic cured, resistant protective coating.

2.7 WARNING TAPE:

- A. Standard, .1mm (4Mil) polyethylene 76 mm (3 inch) wide tape detectable type, green with black letters and imprinted with "CAUTION BURIED SEWER LINE BELOW".

PART 3 - EXECUTION

3.1 BUILDING SERVICE LINES:

- A. Install sanitary sewer service lines to point of connection within approximately 1500 mm (5 feet) outside of buildings where service is required and make connections. Coordinate the invert and location of the service line with the Contractor installing the building lines.
- B. Connections of service line to building piping shall be made after the new sanitary sewer system has been constructed, tested, and accepted for operation by the Resident Engineer. The Contractor shall install all temporary caps or plugs required for testing.
- C. When building services have not been installed at the time when the sanitary sewer system is complete, provide temporary plugs or caps at the ends of all service lines. Mark the location and depth of the service lines with continuous warning tape placed 300 mm (12 inches) above service lines.

3.2 REGRADING:

- A. Raise or lower existing manholes and structures frames and covers, cleanout frames and covers and valve boxes in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Adjust the elevation of the cleanout pipe riser, and reinstall the cap or plug. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.
- C. The Contractor shall comply with all OSHA confined space requirements when working within existing structures.

3.3 PIPE SEPARATION:

A. Horizontal Separation - Water Mains and Sewers:

1. Existing and proposed water mains shall be at least 3 meters (10 feet) horizontally from any proposed gravity flow and pressure (force main) sanitary sewer or sewer service connection.
2. Gravity flow mains and pressure (force) mains may be located closer than 3 meters (10 feet) but not closer than 1.8 m (6 feet) to a water main when:
 - a. Local conditions prevent a lateral separation of ten feet; and
 - b. The water main invert is at least 450 mm (18 inches) above the crown of the gravity sewer or 600 mm (24 inches) above the crown of the pressure (force) main; and
 - c. The water main is in a separate trench separated by undisturbed earth.
3. When it is impossible to meet (1) or (2) above, both the water main and sanitary sewer main shall be constructed of push-on or mechanical joint ductile iron pipe. The pipe for the sanitary sewer main shall comply with the specifications for pressure (force) mains, and the water main material shall comply with Section 33 10 00, WATER UTILITIES. The sewer shall be pressure tested as specified for pressure (force) mains before backfilling.

B. Vertical Separation - Water Mains and Sewers at Crossings:

1. Water mains shall be separated from sewer mains so that the invert of the water main is a minimum of 600 mm (24 inches) above the crown of gravity flow sewer or 1200 mm (48 inches) above the crown of pressure (force) mains. The vertical separation shall be maintained within 3 meters (10 feet) horizontally of the sewer and water crossing. When these vertical separations are met, no additional protection is required.
2. In no case shall pressure (force) sanitary main cross above, or within 600 mm (24 inches) of water lines.
3. When it is impossible to meet (1) above, the gravity flow sewer may be installed 450 mm (18 inches) above or 300 mm (12 inches) below the water main, provided that both the water main and sewer shall be constructed of push-on or mechanical ductile pipe. Pressure (Force) sewers may be installed 600 mm (24 inches) below the water line provided both the water line and sewer line are constructed of ductile iron pipe. The pipe for the sewer shall conform to the requirements for pressure sewers specified herein. Piping for the water main shall conform to Section 33 10 00, WATER UTILITIES.
4. The required vertical separation between the sewer and the water main shall extend on each side of the crossing until the perpendicular

distance from the water main to the sewer line is at least 3 meters (10 feet).

3.4 GENERAL PIPING INSTALLATION:

- A. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade. Pressure (force) mains shall have the bells facing the direction of flow.
- B. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
- C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
- D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
- E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
- F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
- G. Do not lay sewer pipe in same trench with another pipe or other utility. Sanitary sewers shall cross at least 600 mm (2 feet) below water lines.
- H. Do not walk on pipe in trenches until covered by layers of bedding or backfill material to a depth of 300 mm (12 inches) over the crown of the pipe.
- I. Warning tape shall be continuously placed 300 mm (12 inches) above sewer pipe
- J. Install gravity sewer line in accordance with the provisions of these specifications and the following standards:
 - 1. Polyvinyl Chloride (PVC) Piping: ASTM D2321.

3.5 MANHOLES:

- A. General:
 - 1. Circular Structures:
 - a. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 15 mm (1/2 inch) or cement mortar applied with a trowel and finished to an even glazed surface.
 - b. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top, shall be sealed with a preform flexible gasket material

specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.

- c. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.
2. Do not build structures when air temperature is 0 degrees C (32 degrees F), or below.
3. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
 - a. Forming directly in concrete base of structure.
 - b. Building up with brick and mortar.
4. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1:12 (1-inch per foot) nor more than 1:6 (2 inches per foot). Bottom slab and benches shall be concrete.
5. The wall that support access rungs or ladder shall be 90 degrees vertical from the floor of structure to manhole cover.
6. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
7. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 200 mm (8 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.6 SEWER AND MANHOLE SUPPORTS, CONCRETE CRADLES:

- A. Reinforced concrete as detailed on the drawings. The concrete shall not restrict access for future maintenance of the joints within the piping system.

3.7 INSPECTION OF SEWERS:

- A. Inspect and obtain the Resident Engineer's approval. Thoroughly flush out before inspection. Lamp test between structures and show full bore indicating sewer is true to line and grade. Lip at joints on the inside of gravity sewer lines are not acceptable.

3.8 TESTING OF SANITARY SEWERS:

A. Gravity Sewers and Manholes (Select one of the following):

1. Air Test: PVC Pipe, Uni-Bell Uni-B-6. Clean and isolate the section of sewer line to be tested. Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. The line shall be pressurized to 28 kPa (4 psi) and allowed to stabilize. After pressure stabilization, the pressure shall be dropped to 24 kPa (3.5 psi) greater than the average back-pressure of any groundwater above the sewer. The minimum test time shall be as specified in Uni-Bell Uni-B-6.
2. Exfiltration Test:
 - a. Subject pipe to hydrostatic pressure produced by head of water at depth of 900 mm (3 feet) above invert of sewer at upper manhole under test. In areas where ground water exists, head of water shall be 900 mm (3 feet) above existing water table. Maintain head of water for one hour for full absorption by pipe body before testing. During one hour test period, measured maximum allowable rate of exfiltration for any section of sewer shall be 11 L (3.0 gallons) per hour per 30 m (100 feet).
 - b. If measurements indicate exfiltration is greater than maximum allowable leakage, take additional measurements until leaks are located. Repair and retest.
3. Infiltration Test: If ground water level is greater than 900 mm (3 feet) above invert of the upper manhole, infiltration tests are acceptable. Allowable leakage for this test will be the same as for the exfiltration test.

- - - E N D - - -

SECTION 33 10 00
WATER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Underground water distribution system complete, ready for operation, including all appurtenant structures, and connections to both new building service lines and to existing water supply.

1.2 RELATED WORK:

- A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Excavation, trench widths, pipe bedding, backfill, shoring, sheeting, bracing: Section 31 20 00, EARTH MOVING.
- C. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Protection of materials and equipment: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. Fire protection system connection and supervisory switch for post indicator valve: Section 21 10 00, WATER-BASED FIRE-SUPPRESSION SYSTEMS.
- F. Fire protection system connection, Section 21 10 00, WATER-BASED FIRE-SUPPRESSION SYSTEMS.

1.3 DEFINITIONS:

- A. Water Distribution: Pipelines and appurtenances which are part of the distribution system. The distribution system comprises the network of piping located throughout building areas and other areas of water use, including hydrants, valves, and other appurtenances used to supply water for domestic and fire-fighting/fire protection purposes.
- B. Water Service Line: Pipe line connecting building piping to water distribution lines.

1.4 QUALITY ASSURANCE:

- A. Products Criteria:
 - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be product of one manufacturer.
 - 2. Nameplate: Nameplate bearing manufacturer's name or identifiable trademark securely affixed in a conspicuous place on equipment or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Water lines and the extension, and/or modifications to Public Utility systems.

- C. Comply with all rules and regulations of Federal, State, and Local Health Department having jurisdiction over the design, construction, and operation of potable water systems.
- D. All material surfaces in contact with potable water shall comply with NSF 61.

1.5 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data (Submit all items as one package):
(Ductile Iron Pipe and Polyvinyl Chloride (PVC) shall be in accordance with AWWA C600 and C605 respectively; and shall be provided to Resident Engineer for approval.)
 - 1. Piping.
 - 2. Gaskets.
 - 3. Valves.
 - 4. Fire hydrants.
 - 5. Street washer.
 - 6. Meter.
 - 7. Vaults, frames and covers.
 - 8. Steps.
 - 9. Post indicator.
 - 10. Valve boxes.
 - 11. Corporation and curb stops.
 - 12. Curb stop boxes.
 - 13. Joint restraint.
 - 14. Disinfection products.
 - 15. Link/sleeve seals.
- C. Testing Certifications:
 - 1. Certification of Backflow Devices.
 - 2. Hydrostatic Testing.
 - 3. Certification of Disinfection, including free chlorine residuals, and bacteriological examinations.

1.6 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI/ASME):
 - B16.1-98.....Cast Iron Pipe Flanges and Flanged Fittings
 - B16.18.....Cast Bronze Solder Joint Pressure Fittings
 - B16.26-88.....Cast Copper Alloy Fittings for Flared Copper
Tubes

B40.100-98.....Pressure Gauges and Gauge Attachments

C. American Society for Testing and Materials (ASTM):

A123-97.....Zinc (Hot-Dip Galvanized) Coatings on Iron and
Steel Products

A148M-03.....Standard Specifications for Steel Castings

A242-00.....Standard Specifications for High Strength Low
Alloy Structural Steel AASHTO No. M161

A307-02.....Standard Specifications for Carbon Steel Bolts
and Studs, 60,000 psi Tensile Strength

A536-04.....Standard Specifications for Ductile Iron
Castings

B61-02.....Steam or Valve Bronze Castings

B62-02.....Composition Bronze or Ounce Metal Castings

B88-02.....Seamless Copper Water Tube

B828.....Standard Practice: Soldering and Brazing Copper
Tube and fittings

C32-04.....Sewer and Manhole Brick (Made from Clay or
Shale)

C139-03.....Concrete Masonry Units for Construction of Catch
Basins and Manholes

D1784-03.....Standard Specifications for Rigid PVC Compounds
and CPVC Compounds

D1869-00.....Standard Specifications for Rubber Rings for
Asbestos Cement Pipe

D2464-99.....Standard Specifications for Threaded PVC Pipe
Fittings, Schedule 80

D2467-02.....Standard Specifications for Poly (Vinyl
Chloride) (PVC) Plastic Pipe Fittings, Schedule
80

D3139-98.....Joints for Plastic Pressure Pipes Using Flexible
Elastomeric Seals

F477-02e1.....Elastomeric Seals (Gaskets) for Joining Plastic
Pipe

C32-04.....Standard Specifications for Sewer Manhole Brick

D. American Water Works Association (AWWA):

B300-04.....Hypochlorites

B301-04.....Liquid Chlorine

C104-04.....Cement Mortar Lining for Ductile Iron Pipe and
Fittings for Water

C105-99.....Polyethylene Encasement for Gray and Ductile
C.I. Piping for Water and Other Liquids

- C110-03.....Ductile-Iron and Gray-Iron Fittings, 80 mm (3 Inches) Through 1200 mm (48 Inches) for Water and Other Liquids
- C111-01.....Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
- C115-99.....Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
- C150-02.....American National Standard for Thickness Design of Ductile Iron Pipe
- C151-96.....Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
- C153-00.....Ductile-Iron Compact Fittings, 80 mm (3 inches) Through 300 mm (12 Inches) for Water and Other Liquids
- C500-02.....Gate Valves for Water and Sewerage Systems
- C502a-95.....Dry-Barrel Fire Hydrants
- C503-97.....Wet-Barrel Fire Hydrants
- C508-01.....Swing Check Valves for Waterworks Service, 2 Inches (50 mm) Through 24 Inches (600mm) NPS
- C509-01.....Resilient Seated Gate Valve for Water and Sewage System
- C510-97.....Double Check Valve Back-Flow Prevention Assembly
- C511-97.....Reduced Pressure Principle Back-Flow Prevention Assembly
- C550-01.....Protective Epoxy Interior Coatings for Valves and Hydrants
- C600-01.....Installation for Ductile-Iron Water Mains and Their Appurtenances
- C605-94.....Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
- C651-92.....Disinfecting Water Mains
- C800-01.....Underground Service Line Valves and Fittings
- C900-97.....Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Thru 12 Inches, for Water
- C905-97.....Polyvinyl Chloride (PVC) Pressure Pipe 14 Inches Thru 36 Inches
- E. National Fire Protection Association (NFPA):
- 24-95.....Installation of Private Fire Service Mains and Their Appurtenances
- 291-01.....Fire Flow Testing and Marking of Hydrants

1141-98.....Fire Protection in Planned Building Groups

F. NSF International:

14-03.....Plastics Piping Components and Related Materials

61-02.....Drinking Water System Components-Health Effects

(Sections 1-9)

G. American Welding Society (AWS):

A5.8-04.....Brazing Filler Metal

H. Foundation for Cross-Connection Control and Hydraulic Research-2005

I. Copper Development Association's Copper Tube Handbook-2005

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE AND FITTINGS:

A. Ductile iron pipe, direct buried:

1. Provide ductile iron pipe conforming to the requirements of AWWA C151, Pressure Class 350 for Pipe 100 mm through 300 mm (4 inches through 12 inches) in diameter and 250, minimum for pipe larger than 300 mm (12 inches) in diameter, with standard thickness cement mortar lining interior, and interior asphaltic seal coat and exterior asphaltic coating, in accordance with AWWA and ANSI Standards.
2. Below Grade: Supply pipe in lengths not in excess of a nominal 6 m (20 feet) with rubber ring type push-on joints, mechanical joint or approved restrained joint. Provide flange joint pipe where shown on the drawings. Provide mechanical and restrained joint pipe with sufficient quantities of accessories as required for each joint.
3. When a polyethylene encasement over pipe, fittings, and valves is a requirement as indicated on the drawings, the material, installation and workmanship shall conform to applicable sections of AWWA C105. Make provisions to keep the polyethylene from direct exposure to sunlight prior to installation. Backfill following installation without delay to avoid exposure to sunlight.

B. Ductile Iron Pipe Above Grade or in Below Ground Concrete Pits:

1. Flanged ductile iron pipe, AWWA C115, with factory applied screwed long hub flanges except as otherwise specified hereinafter. Face and drill flanges after being screwed on the pipe, with flanges true to 90 degrees with the pipe axis and flush with end of pipe, ANSI B16.1, 850 kPa (125 psi) or 1725 kPa (250 psi) standard, for the purpose intended.
2. Wall Sleeve Castings: Size and types shown on the drawings and be hot dipped galvanized. Seal strips, where required shall be Link Seal as manufactured by Thunderline Corp., Wayne, Michigan or equal.
3. Pipe Thickness Class: Minimum of Class 53 as defined in AWWA C150 for all sizes of flanged pipe.

4. Rubber Ring Gaskets: Full face type, AWWA C111, 2 mm (1/16 inch) rubber ring gaskets and of approved composition suitable for the required service.
5. Pipe and fittings exposed to view in the finished work are to be painted in accordance with Section 09 91 00, PAINTING. Pipe shall not receive the standard tar or asphalt coat on the outside surfaces but shall be shop primed on the outside with one coat of Kop-Coat No. 621 Rust Inhibitive Primer or equal. Paint color shall match the wall color.
6. Bolts and Nuts on Flanged Fittings: Grade B, ASTM A307. Low alloy, high strength steel in accordance with AWWA C111. Assemble stainless steel bolts and nuts using anti-seize compound to prevent galling.
- C. All Pipe Fittings: Ductile iron with a minimum pressure rating of 2400 kPa (350 psi). Fittings shall meet the requirements of ANSI and AWWA specifications as applicable. Rubber gasket joints shall conform to AWWA C111 for mechanical and push-on type joints. Ball joints shall conform to AWWA C151 with a separately cast ductile iron bell conforming to ASTM A148. Flanged fittings shall conform to AWWA C115 and be furnished flat faced and drilled to 850 kPa (125 psi) or 1725 kPa (250 psi) template in accordance with ANSI B16.1 with full faced gaskets.
- D. Provide cement mortar lining and bituminous seal coat on the inside of the pipe and fittings in accordance with AWWA C104. Provide standard asphaltic coating on the exterior.
- E. Provide a factory hydrostatic test of not less than 3.5 MPa (500 psi) for all pipe in accordance with AWWA C151.
- F. Provide non-detectable adhesive backed identification tape on top and sides of all buried ductile iron pipe, extended from joint to joint along the length of the pipe and have black lettering identifying the pipe service at no more than 300 mm (12 inch) intervals. According to service, the tape background color shall be as follows: Potable water-blue.

2.2 VALVES:

- A. Asbestos packing is not allowed.
- B. Gate:
 1. 75 mm (3 inches) and Larger: Resilient seated, ductile iron body, bronze mounted, inclined seats, non-rising stem type turning counter-clockwise to open, 1375 kPa (200 pound) WOG. AWWA C509. The resilient seat shall be fastened to the gate with stainless steel fasteners or vulcanizing methods. The interior and exterior shall be coated with thermo-setting or fusion epoxy coating in accordance with AWWA C550.
2. Operator:

- a. Underground: Except for use with post indicators, furnish valves with 50 mm (2 inch) nut for socket wrench operation. Post indicator shall comply with the requirements of NFPA 24 and shall be fully compatible with the valve provided.
- b. Above Ground and in Pits: Hand wheels.
- 3. Joints: Ends of valves shall accommodate, or be adapted to, pipe installed.
- C. Check: Swing.
 - 1. Smaller than 100 mm (4 inches): Bronze body and bonnet, ASTM B61 or B62, 1375 kPa (200 pound) WOG.
 - 2. 100 mm (4 inches) and Larger: Iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, 1375 kPa (200 pound) WOG. Check valves for fire lines shall conform to AWWA C508 and shall be epoxy coated and lined per AWWA C550.
- D. Corporation stops and saddles shall conform to AWWA C800.
- E. Curb Stop: Smaller than 75 mm (3 inches). Waterworks standard for Type "K" copper, single piece cast bronze body with tee top operated plug sealed with O-ring gaskets, 1375 kPa (200 pound) WOG per AWWA C800.

2.3 CURB STOP BOX:

- A. Cast iron extension box with screw or slide type adjustment and flared base. Box shall be adapted, without full extension, to depth of cover required over pipe at stop location. Cast the word "WATER" in cover and set cover flush with finished grade. Curb stop shut-off rod shall extend 600 mm (2 feet) above top of deepest stop box.

2.4 VALVE BOX:

- A. Cast iron extension box with screw or slide-type adjustment and flared base. Minimum thickness of metal shall be 5 mm (3/16 inch). Box shall be adapted, without full extension, to depth of cover required over pipe at valve location. Cast the word "WATER" in cover. Provide [2] "T" handle socket wrenches of 16 mm (5/8 inch) round stock long enough to extend 600 mm (2 feet) above top of deepest valve box.

2.5 POST INDICATOR VALVE:

- A. Valve: Valve shall conform to the specifications listed in Section 2.4 for gate valves. The Post Indicator shall conform to NFPA 24, and shall be fully compatible with the valve and all the supervisory switches.

2.6 FIRE HYDRANTS:

- A. Size of main valve opening of each hydrant shall be 125 mm (5 inches), minimum. Hose thread, size of fire apparatus connection, and shape, size and direction of rotation of operating head of hydrant shall be

identical with present local fire department and/or water department standards.

- B. Hydrant shall be type AWWA C502, heavy construction, of proper length to connect pipe without extra fittings, and shall be the traffic type with safety flange on barrel and safety couplings on the valve stem with the following features:

1. Interior removable without digging up hydrant; can be packed under pressure; 150 mm (6 inch) bell connection; one steamer nozzle and two hose nozzles with nozzle caps securely chained to barrel; suitable drainage device; single rubber or leather-faced valve in base; nozzles, stuffing boxes, wedge nuts, seat rings, clamp plates, etc. Threaded joints or spindles shall be bronze. Upper and lower barrels shall be of equal diameters. Upper barrel shall be of sufficient length to permit setting hydrant with barrel flange not more than 50 mm (2 inches) above finished grade. All fire hydrants shall have 150 mm (6 inch) bottom connection.
2. Provide fire hydrants with a finish paint identical to the existing fire hydrants.

- C. Provide 3 wrenches with handles not less than 350 mm (14 inches) long.

2.7 PIPE SLEEVES:

- A. Ductile iron or zinc coated steel.

2.8 FLEXIBLE EXPANSION JOINTS: (PROVIDE FOR DOMESTIC AND FIRE SERVICE)

- A. Ductile iron with ball joints rated for 1725 kPa (250 PSI) working pressure conforming to ANSI/AWWA A21.53/C153, capable of deflecting a minimum of 30 degrees and expanding simultaneously to the amount shown on the drawings. Flexible expansion joint shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be lined with a minimum of 375 µm (15 mils) of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be factory holiday tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to ANSI/AWWA A21.11/C110. Bolts and nuts high strength steel with synthetic gaskets that comply with AWWA C110.

2.9 POTABLE WATER:

- A. Water used for filling, flushing, and disinfection of water mains and appurtenances shall conform to Safe Drinking Water Act.

2.10 DISINFECTION CHLORINE:

- A. Liquid chlorine shall conform to AWWA B301 and AWWA C651.
- B. Sodium hypochlorite shall conform to AWWA B300 with 5 percent to 15 percent available chlorine.

- C. Calcium hypochlorite shall conform to AWWA B300 supplied in granular form or 5.g tablets, and shall contain 65 percent chlorine by weight.

2.11 WARNING TAPE

- A. Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape, detectable type, blue with black letters, and imprinted with "CAUTION BURIED WATER LINE BELOW".

PART 3 - EXECUTION**3.1 BUILDING SERVICE LINES:**

- A. Install water service lines to point of connection within approximately 1500 mm (5 feet) outside of buildings to which such service is to be connected and make connections thereto. If building services have not been installed provide temporary caps.

3.2 REGRADING:

- A. Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

3.3 PIPE LAYING, GENERAL:

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Resident Engineer.
- B. All pipe and fittings shall be subjected to a careful inspection just prior to being laid or installed. If any defective piping is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the Government. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.
- C. All buried piping shall be installed to the lines and grades as shown on the drawings. All underground piping shall slope uniformly between joints where elevations are shown.
- D. Contractor shall exercise extreme care when installing piping to shore up and protect from damage all existing underground water line and power lines, and all existing structures.
- E. Do not lay pipe on unstable material, in wet trench, or when trench or weather conditions are unsuitable.
- F. Do not lay pipe in same trench with other pipes or utilities unless shown otherwise on drawings.
- G. Hold pipe securely in place while joint is being made.

- H. Do not walk on pipes in trenches until covered by layers of earth well tamped in place to a depth of 300 mm (12 inches) over pipe.
- I. Full length of each section of pipe shall rest solidly upon pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipes on wood blocking.
- J. Tees, plugs, caps, bends and hydrants on pipe installed underground shall be anchored.
- K. Close pipe openings with caps or plugs during installation. Tightly cover and protect equipment against dirt, water and chemical, or mechanical injury. At completion of all work, thoroughly clean exposed materials and equipment.
- L. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by the manufacturer.
- M. Warning tape shall be continuously placed 300 mm (12 inches) above buried water pipes.

3.4 DUCTILE IRON PIPE:

- A. Installing Pipe: Lay pipe in accordance with AWWA C600 with polyethylene encasement if required in accordance with AWWA C105. Provide a firm even bearing throughout the length of the pipe by tamping selected material at the sides of the pipe up to the spring line.
- B. All pipe shall be sound and clean before laying. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or other approved means.
- C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Bevel cut ends of pipe to be used with push-on bell to conform to the manufactured spigot end. Cement lining shall be undamaged.
- D. Jointing Ductile-Iron Pipe:
 - 1. Push-on joints shall be made in strict accordance with the manufacturer's instruction. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe is to be aligned with the bell of the pipe to which it is joined, and pushed home with approved means.
 - 2. Mechanical Joints at Valves, Fittings: Install in strict accordance with AWWA C111. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gaskets with soapy water before tightening the bolts. Bolts shall be tightened to the specified torque.
 - 3. Ball Joints: Install in strict accordance with the manufacturer's instructions. Where ball joint assemblies occur at the face of

structures, the socket end shall be at the structure and ball end assembled to the socket.

4. Flanged joints shall be in accordance with AWWA C115. Flanged joints shall be fitted so that the contact faces bear uniformly on the gasket and then are made up with relatively uniform bolt stress.

3.5 RESTRAINED JOINTS:

- A. Sections of piping requiring restrained joints shall be constructed using pipe and fittings with restrained "locked-type" joints and the joints shall be capable of holding against withdrawal for line pressures 50 percent above the normal working pressure but not less than 1375 kPa (200 psi). The pipe and fittings shall be restrained push-on joints or restrained mechanical joints.
- B. The minimum number of restrained joints required for resisting force at fittings and changes in direction of pipe shall be determined from the length of retained pipe on each side of fittings and changes in direction necessary to develop adequate resisting friction with the soil. Restrained pipe length shall be as shown on the drawings.
- C. Restrained joint assemblies with ductile iron mechanical joint pipe shall be "Flex-Ring", "Lok-Ring", or mechanical joint coupled as manufactured by American Cast Iron Pipe Company, "Mega-Lug" or approved equal.
- D. Ductile iron pipe bell and spigot joints shall be restrained with EBBA Iron Sales, Inc. Series 800 Coverall or approved equal.
- E. Ductile iron mechanical joint fittings shall be restrained with EBBA Iron Sales, Inc. Series 1200 Restrainer. The restraining device shall be designed to fit standard mechanical joint bells with standard T head bolts conforming to AWWA C111 and AWWA C153. Glands shall be manufactured of ductile iron conforming to ASTM A536. Set screws shall be hardened ductile iron and require the same torque in all sizes. Steel set screws not permitted. These devices shall have the stated pressure rating with a minimum safety factor of 2:1. Glands shall be listed with Underwriters Laboratories and/or approved by Factory Mutual.
- F. Thrust blocks shall not be permitted.
- G. Where ductile iron pipe manufactured with restrained joints is utilized, all restrained joints shall be fully extended and engaged prior to back filling the trench and pressurizing the pipe.
- H. Ductile iron mechanical joint fittings used with PVC pipe shall be restrained with UNI-Flange Corp. Series 1300 Restrainer, EBBA Iron, Inc, Series 2000PV Mechanical Joint Restrainer Gland, or approved equal. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A-536. Clamping bolts and nuts shall

be manufactured of corrosion resistant high strength, low alloy steel meeting the requirements of ASTM A242.

3.6 PIPE SEPARATION:

A. Horizontal Separation-Water Mains and Sewers:

1. Water mains shall be located at least 3 m (10 feet) horizontally from any proposed drain, storm sewer, sanitary or sewer service connection.
2. Water mains may be located closer than 3 m (10 feet) to a sewer line when:
 - a. Local conditions prevent a lateral separation of 3 m (10 feet); and
 - b. The water main invert is at least 450 mm (18 inches) above the crown of the sewer; and
 - c. The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located one side of the sewer.
3. When it is impossible to meet (1) or (2) above, both the water main and drain or sewer shall be constructed of mechanical joint ductile iron pipe. Ductile iron pipe shall comply with the requirements listed in this specification section. The drain or sewer shall be pressure tested to the maximum expected surcharge head before back filling.

B. Vertical Separation-Water Mains and Sewers:

1. A water main shall be separated from a sewer so that its invert is a minimum of 450 mm (18 inches) above the crown of the drain or sewer whenever water mains cross storm sewers, sanitary sewers or sewer service connections. The vertical separation shall be maintained for that portion of the water main located within 10 feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.
2. Both the water main and sewer shall be constructed of slip-on or mechanical joint ductile iron pipe or PVC pipe equivalent to water main standards of construction when:
 - a. It is impossible to obtain the proper vertical separations described in (1) above; or
 - b. The water main passes under a sewer or drain.
3. A vertical separation of 450 mm (18 inches) between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and breaking the water main.

4. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least 3 m (10 feet).

3.7 SETTING OF VALVES AND BOXES:

- A. Provide a surface concrete pad 450 by 450 by 150 mm (18 by 18 by 6 inches) to protect valve box when valve is not located below pavement.
- B. Clean valve and curb stops interior before installation.
- C. Set valve and curb stop box cover flush with finished grade.
- D. Valves shall be installed plumb and level and in accordance with manufacturer's recommendations.

3.8 SETTING OF FIRE HYDRANTS:

- A. Set center of each hydrant not less than 600 mm (2 feet) nor more than 1800 mm (6 feet) back of edge of road or face of curb. Fire apparatus connection shall face road with center of nozzle 450 mm (18 inches) above finished grade. Set barrel flange not more than 50 mm (2 inches) above finished grade.
- B. Set each hydrant on a slab of stone or concrete not less than 100 mm (4 inches) thick and 375 mm (15 inches) square. The service line to the hydrant, between the tee and the shoe of the hydrant, shall be fully restrained.
- C. Set bases in not less than 0.4 cubic meter (1/2 cubic yard) of crushed rock or gravel placed entirely below hydrant drainage device.
- D. Clean interiors of hydrants of all foreign matter before installation.

3.9 PIPE SLEEVES:

- A. Install where water lines pass through retaining walls, building foundations and floors. Seal with modular mechanical type link seal. Install piping so that no joint occurs within a sleeve. Split sleeves may be installed where existing lines pass through new construction.

3.10 FLUSHING AND DISINFECTING:

- A. Flush and disinfect new water lines in accordance with AWWA C651.
- B. Initial flushing shall obtain a minimum velocity in the main of 0.75 m/sec (2.5 feet per second) at 40 PSI residual pressure in water main. The duration of the flushing shall be adequate to remove all particles from the line.

Pipe Diameter		Flow Required to Produce 2.5 ft/sec (approx.) Velocity in Main		Number of Hydrant Outlets			
				Size of Tap. in. (mm)			
In	(mm)	gpm	(L/sec)	1 (25)	1 ½ (38)	2 (51)	2 1/2-in (64 mm)
				Number of taps on pipe			
4	(100)	100	(6.3)	1	--	--	1

6	(150)	200	(12.6)	--	1	--	1
8	(200)	400	(25.2)	--	2	1	1
10	(250)	600	(37.9)	--	3	2	1
12	(300)	900	(56.8)	--	--	3	2
16	(400)	1,600	(100.9)	--	--	4	2

The backflow preventers shall not be in place during the flushing.

- C. The Contractor shall be responsible to provide the water source for filling, flushing, and disinfecting the lines. Only potable water shall be used, and the Contractor shall provide all required temporary pumps, storage facilities required to complete the specified flushing, and disinfection operations.
- D. The Contractor shall be responsible for the disposal of all water used to flush and disinfect the system in accordance with all governing rules and regulations. The discharge water shall not be allowed to create a nuisance for activities occurring on or adjacent to the site.
- E. The bacteriological test specified in AWWA C651 shall be performed by a laboratory approved by the Health Department of the Commonwealth of Pennsylvania. The cost of sampling, transportation, and testing shall be the responsibility of the Contractor.
- F. Re-disinfection and bacteriological testing of failed sections of the system shall be the sole responsibility of the Contractor.
- G. Before backflow preventers are installed, all upstream piping shall be thoroughly flushed.

3.11 HYDROSTATIC TESTING:

- A. Hydrostatic testing of the system shall occur prior to disinfecting the system.
- B. After new system is installed, except for connections to existing system and building, backfill at least 300 mm (12 inches) above pipe barrel, leaving joints exposed. The depth of the backfill shall be adequate to prevent the horizontal and vertical movement of the pipe during testing.
- C. Prior to pressurizing the line, all joint restraints shall be completely installed and inspected.
- D. If the system is tested in sections, and at the temporary caps at connections to the existing system and buildings, the Contractor shall provide and install all required temporary thrust restraints required to safely conduct the test.
- E. The Contractor shall install corporation stops in the line as required to purge the air out of the system. At the completion of the test, all corporation stops shall be capped.

F. The Contractor shall perform pressure and leakage tests for the new system for 2 hours to 1375 kPa (200 psi). Leakage shall not exceed the following requirements.

1. Copper Tubing: No leaks.
2. Ductile Iron Pipe: AWWA C600. Provide to Resident Engineer office.
3. Polyvinyl Chloride (PVC) AWWA C605. Provide to Resident Engineer office.

- - - E N D - - -

SECTION 33 40 00
STORM DRAINAGE UTILITIES**PART 1 - GENERAL****1.1 DESCRIPTION:**

- A. This section specifies construction of outside, underground storm sewer systems. The storm sewer systems shall be complete and ready for operation, including all drainage structures, frames, grate and covers, connections to new buildings, structure service lines, existing storm sewer lines and existing drainage structures and all required incidentals.

1.2 RELATED WORK:

- A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- C. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATIONS.
- E. Protection of Materials and Equipment: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.3 QUALITY ASSURANCE:

- A. Products Criteria:
1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to public storm sewer lines and the extension, and/or modifications to Public Utility systems.

1.4 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data: Submit the following as one package:
1. Piping.
 2. Jointing material.
 3. Manhole, inlet and catch basin material.
 4. Frames and covers.

- 5. Steps.
- 6. Resilient connectors and downspout boots.
- C. One copy of State Department of Transportation standard details of MANHOLES, INLETS and catch basins.
- D. One copy of State Department of Transportation specification.

1.5 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - A48-03/A48M-03.....Gray Iron Castings
 - A536-84(2004).....Ductile Iron Castings
 - A615-05/A615M-05.....Deformed and Plain-Billet Steel Bars for
Concrete Reinforcement
 - C76-05a/C76M-05a.....Reinforced Concrete Culvert, Storm Drain and
Sewer Pipe
 - C150-04ae1.....Portland Cement
 - C478-03a/C478M-03a.....Precast Reinforced Concrete Manhole Sections
 - C1433-04e1/C1433M-04e1..Precast Reinforced Concrete Box Sections for
Culverts, Storm Drains and Sewers
 - C857-07.....Minimum Structural Design Loading for
Underground Precast Concrete Utility Structures
 - C990-09.....Standard Specification for Joints for Concrete
Pipe, Manholes and Precast Box Sections using
Preformed Flexible Joint Sealants
 - D698-00ae1.....Laboratory Compaction Characteristics of Soil
Using Standard Effort (12,400 ft-lbf/ft³ (600
kN-m/m³))
 - D-1227-95.....Standard Specification for Emulsified Asphalt
used as Protective Coating for Roofing
 - D2321-04e1.....Underground Installation of Thermoplastic Pipe
for Sewers and Other Gravity Flow Applications.
 - D3212-07.....Standard Specification for Joints for Drain and
Sewer Plastic Pipes using Flexible Elastomeric
Seals.
 - D4101-05a.....Polypropylene Injection and Extrusion Materials
 - F477-10.....Standard Specification for Elastomeric Seals
(Gaskets) for joining plastic pipe
 - F2487-06.....Standard Practice for Infiltration and
Exfiltration Acceptance Testing of Installed
Corrugated High Density Polyethylene Pipelines

F2736-10.....Standard Specification for 6" to 30" (152mm to 762mm) Polypropylene (PP) Corrugated Single Wall and Double Wall Pipe

NOTE: ASTM test methods shall be the current version as of the date of advertisement of the project.

PART 2 - PRODUCTS

2.1 PIPING:

A. Gravity Lines (Pipe and Appurtenances):

1. ADS N-12® HP 12" - 60" PIPE

- a. 12-through 30-inch (300mm to 750mm) pipe shall have a smooth interior and annular exterior corrugations and meets ASTM F2736

2.2 JOINTING MATERIAL:

A. ADS N-12 HP 12" to 60" Pipe:

1. Pipe shall be joined with a gasketed integral bell & spigot joint meeting the requirements of ASTM F2736, for applicable diameters. 12-through-60-inch (300mm to 1500mm) shall be watertight according to the requirements of ASTM D3212. Spigots shall have gaskets meeting the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 750mm) diameters shall have reinforced bell with a polymer composite band installed by the manufacturer.
2. Fittings shall conform to ASTM F2736, for applicable diameters. Bell & spigot connections shall utilize a spunon, welded or integral bell and spigot with gaskets meeting ASTM F477. Fitting joints shall meet the water tight joint performance requirements of ASTM F2736 or ASTM D3212.
3. To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F2487. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

2.3 MANHOLES, INLETS AND CATCH BASINS:

- #### **A. Manholes, inlets and catch basins shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. Manholes, inlets and catch basins shall be in accordance with State Department of Transportation standard details, and the following VA requirements, in case of variance, VA requirements supersede:**

1. Precast Concrete Segmental Blocks: Blocks shall conform to ASTM C139 and shall not be less than 150 mm (6 inches) thick for manholes to a depth of 3.6 m (12 feet); not less than 200 mm (8 inches) thick for manholes deeper than 3.6 m (12 feet) deep. Blocks shall be not less than 200 mm (8 inches) in length. Blocks shall be shaped so that joints seal and bond effectively with cement mortar. Parge structure interior and exterior with 15 mm (1/2 inch) of cement mortar applied with a trowel and finished to an even glazed surface.
2. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
3. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
4. Precast Catch Basins: Concrete for precast sections shall have a minimum compressive strength of 35 MPa (5,000 psi) at 28 days, ASTM A615, Grade 60 reinforcing steel, rated for AASHTO HS20-44 loading with 30 percent impact, and conform to ASTM C-857.
5. Mortar:
 - a. Precast Concrete Segmental Block Structures: By volume, 1 part of Portland cement, 1/4 part lime hydrate, and 3 parts sand.
 - b. Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21L (5-1/2 gallons) per sack of cement.
6. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M-198B.
7. Frames and covers shall be gray cast iron conforming to ASTM A48. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover, and the words "storm sewer". The studs and the lettering shall be raised 8 mm (5/16 inch). The cover shall be a minimum of 600 mm (24 inches) in diameter and shall have four 19 mm (3/4 inch) vent holes and two lifting slots. The bearing surface of

the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.

8. Manhole steps shall be polypropylene plastic coated on a No. 4 deformed rebar conforming to ASTM C478, Polypropylene shall conform to ASTM D4101. Steps shall be a minimum of 250 mm (10 inches) wide and project a minimum of 125 mm (5 inches) away from the wall. The top surface of the step shall have a studded non-slip surface. Steps shall be placed at 300 mm (12 inch) centers.

9. Ladders, brackets and hardware shall be constructed of welded aluminum, rails shall be 9 mm (3/8 inch) by 63 mm (2-1/2 inches) spaced a minimum of 400 mm (16 inches) apart. Rungs shall be 35 mm (1-3/8 inches) in diameter and have a non-slip surface. Standoffs shall offset the ladder 180 mm (7 inches) from the wall. The ladder assembly shall be rated for a minimum of 2200 N (500 pounds).

- B. Frame and Cover for Gratings: Frame and cover for gratings shall be cast gray iron conforming to ASTM A48; cast ductile iron conforming to ASTM A536 in accordance with State Department of Transportation standard details. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the drawings.

2.4 CONCRETE:

- A. Concrete shall be in accordance with State Department of Transportation standard specification 408. For concrete not specified in above standards, concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform to the provisions of Division 03 of these specifications.

2.5 REINFORCING STEEL:

- A. Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.6 PRECAST REINFORCED CONCRETE BOX.

- A. Precast Reinforced Concrete Box: For highway loadings with 600 mm (2 feet) of cover or more subjected to dead load only, conform to ASTM C1433; For less than 600 mm (2 feet) of cover subjected to highway loading, conform to ASTM C1433.

2.7 RESILIENT CONNECTORS AND DOWNSPOUT BOOTS:

- A. Resilient Connectors: Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923.
- B. Downspout Boots: Boots used to connect exterior downspouts to the storm drainage system shall be of gray cast iron conforming to ASTM A48, Class 30B or 35B.

2.8 WARNING TAPE:

- A. Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, purple with black letters, and imprinted with "CAUTION BURIED STORM SEWER BELOW".

PART 3 - EXECUTION**3.1 EXCAVATION FOR STORM DRAINS AND DRAINAGE STRUCTURES:**

Excavation of trenches and for appurtenances and backfilling for storm drains, shall be in accordance with the applicable portions of Section 31 20 00, EARTH MOVING.

3.2 PIPE BEDDING:

- A. The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall not be more than the length, depth, and width required for properly making the particular type of joint. Plastic pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be either Class IB or Class II material.

3.3 GENERAL PIPING INSTALLATION:

- A. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade.
- B. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
- C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
- D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
- E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
- F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
- G. Do not lay sewer pipe in same trench with another pipe or other utility.
- H. Do not walk on pipe in trenches until covered by layers of shading to a depth of 300 mm (12 inches) over the crown of the pipe.
- I. Warning tape shall be continuously placed 300 mm (12 inches) above storm sewer piping.

3.4 REGRADING:

- A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.
- C. The Contractor shall comply with all OSHA confined space requirements when working within existing structures.

3.5 MANHOLES, INLETS AND CATCH BASINS:

A. General:

1. Circular Structures:

- a. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 15 mm (1/2 inch) or cement mortar applied with a trowel and finished to an even glazed surface.
- b. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
- c. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

2. Rectangular Structures:

- a. Reinforced concrete structures shall be installed in accordance with Division 03, CONCRETE of these specifications.
- b. Precast concrete structures shall be placed on a 200 mm (8 inch) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on a 200 mm (8 inches) thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by ASTM D 698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.

3. Do not build structures when air temperature is 0 degrees C (32 degrees F), or below.
4. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
 - a. Forming directly in concrete base of structure.
 - b. Building up with brick and mortar.
5. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1:12 (25mm per 300mm, 1-inch per foot) nor more than 1:6 (50mm per 300mm, 2 inches per foot). Bottom slab and benches shall be concrete.
6. The wall that supports access rungs or ladder shall be 90 degrees vertical from the floor of structure to manhole cover.
7. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
8. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 200 mm (8 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.6 CURB INLETS, CATCH BASINS, AND AREA DRAINS:

- A. Reinforced concrete as shown or precast concrete.

- - - E N D - - -

SECTION 33 46 13
FOUNDATION DRAINAGE**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies foundation drainage system, including installation, backfill, and cleanout extensions, to place of connection to storm sewer.

1.2 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples: For each type of filter fabric, pipe, and fitting indicated
- C. Product Data: Certifications from the manufacturers attesting that materials meet specification requirements.

1.3 RELATED WORK:

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Safety requirements: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.
- C. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.
- E. Foundation Waterproofing: Section 07 13 52, MODIFIED BITUMINOUS SHEET WATERPROOFING.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred in the text by basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
- HB17-02.....Standard Spec for Highway Bridges, Div II,
Section 36.4.2.4, Joint Properties.
- M6-03.....Fine Aggregate for Portland Cement Concrete
- M86/M86M-06.....Concrete Sewer, Storm Drain, and Culvert Pipe
- M175/M175M-05.....Perforated Concrete Pipe

M288-06.....Geotextile Specification for Highway
Applications

T281-06.....Vitrified Clay Pipe

C. American Society for Testing and Materials (ASTM):

A74-05.....Standard Specification for Cast Iron Soil Pipe
and Fittings

A746-03.....Standard Specification for Ductile Iron Gravity
Sewer Pipe

C14/C14M-05aStandard Specification for Non-reinforced
Concrete Sewer, Storm Drain, and Culvert Pipe

C118/C118M-05a.....Standard Specification for Concrete Pipe for
Irrigation or Drainage

C443/C443M-05a.....Standard Specification for Joints for Concrete
Pipe and Manholes, Using Rubber Gaskets

C444/C444M-03.....Standard Specification for Perforated Concrete
Pipe

D448-03a.....Standard Classification for Sizes of Aggregate
for Road and Bridge Construction

D2321-05.....Standard Practice for Underground Installation
of Thermoplastic Pipe for Sewers and Other
Gravity-Flow Applications

D2729-03.....Standard Specification for Poly(Vinyl Chloride)
(PVC) Sewer Pipe and Fittings

D2737-03.....Standard Specification for Polyethylene (PE)
Plastic Tubing

D3034-06.....Standard Specification for Type PSM Poly(Vinyl
Chloride) (PVC) Sewer Pipe and Fittings

D4216-03.....Standard Specification for Rigid Poly (Vinyl
Chloride) (PVC) and Related PVC and Chlorinated
Poly (Vinyl Chloride) (CPVC) Building Products
Compounds

F477-02e1.....Standard Specification for Elastomeric Seals
(Gaskets) for Joining Plastic Pipe

F758-95(2000)Standard Specification for Smooth-Wall Poly
(Vinyl Chloride) (PVC) Plastic Underdrain Systems
for Highway, Airport, and Similar Drainage.

PART 2 - PRODUCTS**2.1 MATERIALS****A. Underslab Header:**

1. ASTM A74 or ASTM A746 cast-iron soil pipe and fittings in NPS 4 to NPS 15 (DN 100 to DN 375). Joints shall be hub-and-spigot, gasket type.
2. PE drainage tubing and fittings per ASTM D2737, in NPS 4 to NPS 10 (DN 100 to DN 250). Joints shall be coupling type.
3. PVC sewer pipe and fittings per ASTM D3034, in NPS 4 to NPS 15 (DN 100 to DN 375). Joints shall be bell-and-spigot. ASTM F477, elastomeric seal gaskets shall be used.

B. Perforated Drainage Pipe:

1. Perforated, PE pipe and fittings per ASTM D2737, in NPS 4 to NPS 6 (DN 100 to DN 150). Joints shall be coupling type.
2. Perforated, PVC sewer pipe and fittings per ASTM D2729, in NPS 4 (DN 100) only. Joints shall be bell-and-spigot, loose type.

C. Cleanout Extension: ASTM A74, cast iron pipe or ASTM A746 ductile iron. Gravity Sewer pipes shall have a neoprene gasket joints and long sweep elbow fittings.**D. Drainage Conduit:**

1. Pipe, fittings, and couplings shall be perforated and smooth PVC complying with ASTM D4216 and ASTM D2729.
2. Pipe size shall be 200 mm (8 inches) and have a high minimum flow rate equal to a NPS 4 (DN 100) pipe.
3. Fittings shall be PVC with NPS 4 (DN 100) outlet connection.
4. Couplings shall be PVC.

E. Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:**F. Drainage Mat:** Formed three dimensional polyethylene or high-impact polymeric core or compression-resistant nylon matting of open three-dimensional construction.**G. Drainage Material:**

1. Bedding: Crushed stone, 20 mm (3/4 inch) to No. 4 per ASTM D448.
2. Fill to 300 mm (1 foot) above pipe: Crushed stone, 20 mm (3/4 inch) to No. 4 per ASTM D448.

H. Concrete Sand: AASHTO M6.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Laying: Prior to installation of bedding materials or piping, examination of excavation and subgrades are to be observed by the Resident Engineer. Invert elevation of drain pipe shall not be higher than top of lowest floor elevation nor lower than a 45 degree line projected from bottom of any adjacent footing. Lay drain lines and firmly bed in granular material a minimum of 75 mm (3 inches) below invert to top of pipe to true grades and alignment with bells facing upgrade, and to slope uniformly between elevations shown on foundation drainage drawings. Keep trenches dry until pipe is in place and granular material backfill is completed to 300 mm (1 foot) above top of pipe, unless otherwise noted.

1. Install gaskets, seals, sleeves, and couplings according to manufacturers written instructions and per the applicable standard:
 - a. PE and PVC pipe installation shall be per ASTM D2321 and ASTM F758.
 - c. PE joint construction shall be per ASTM D2737 and AASHTO HB17, Division II, Section 26.4.2.4, "Joint Properties."
 - d. PVC joint construction shall be per ASTM D3034 with elastomeric seals gaskets per ASTM D2321.
 - e. Perforated PVC joint construction shall be per ASTM D2729, with loose bell and spigot joints.
 2. Lay perforated pipe with perforations down. Lay plain end pipe with closed joints held in place with two No. 9 spring steel wire clips at each joint or by standard clay collars.
 3. For foundation subdrainage, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 900 mm (3 feet), unless otherwise indicated.
 4. For underslab subdrainage, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
 5. Install cleanout extensions where shown on the Contract Documents.
 6. Prior to backfilling, check drain lines to assure free flow. Remove obstructions and recheck lines until satisfactory.
- B. Backfilling: Place a minimum of 300 mm (12 inches) of granular material, hand tamped, extending in width a minimum of 600 mm (2 feet) from building wall. Then place a minimum of 150 mm (6 inches) of

concrete sand, well tamped. Continue backfill with pit run sand and gravel with a maximum plasticity index of 6 to within 900 mm (3 feet) of finished grade in planting areas. Remainder of backfill shall be comparable to existing adjacent soils. In bituminous and concrete paving areas, backfill to the bottom of the base course with pervious material. Where foundation drain is within 600 mm (2 feet) of finished grade, one-half of fill shall be made with crushed stone.

- C. Filter fabric may be substituted for sand layer.
- D. Vertical drainage mat in conjunction with geotextile may be substituted for sand and drainage material.
- E. When drain lines are left open for connection to discharge line, the open ends shall be temporarily closed and their location marked with wooden stakes.

- - -E N D - - -

SECTION 33 63 00**STEAM ENERGY DISTRIBUTION****PART 1 - GENERAL****1.1 DESCRIPTION**

Underground steam distribution and condensate return piping system, including manholes. Type of system shall be: pre-engineered direct-buried drainable-dryable-testable (DDT).

1.2 DEFINITIONS

- A. System: A complete underground steam and condensate distribution system including all components such as carrier piping, pipe supports, insulation, protective enclosures, anchors, corrosion protection and accessories.
- B. Pre-Engineered Direct-Buried System: System that is designed and factory-fabricated by a company specializing in these systems. The system includes pre-fabricated protective enclosures and does not require a concrete trench or tunnel. The pre-engineered system shall include all piping and components to a point at least 150 mm (6 inches) inside the building and manhole walls.
- C. Drainable-Dryable-Testable (DDT) Pre-Engineered Direct-Buried System: A factory-fabricated system including an airtight and watertight outer protective casing, an insulated carrier pipe and an air space between the insulated carrier pipe and the casing. Drains and vents are provided in the ends of the system (in manholes or buildings). The drains allow draining of ground water or condensate that may leak into the air space if there is a failure in the casing or the carrier pipe. The vents allow water vapor to escape and provide an indication of leakage.
- D. Carrier Pipe: Pipe carrying the steam or condensate.
- E. Casing: Outer protective pipe on pre-engineered systems. Carrier pipe and insulation are within the casing. The casing may also be referenced as the "conduit".
- F. Project Drawings: The project drawings accompanying this specification provide information on:
 - 1. The size of carrier pipes, approximate length, and site location of the system.
 - 2. The elevation and routing of the piping on the site.
 - 3. Location and design of manholes and piping therein.
 - 4. The obstacles located within approximately 25 m (8 feet) of the centerline of the system, including crossing utilities, that must be avoided or altered.
 - 5. Type of system required pre-engineered direct-buried.

6. Location of piping anchors.
7. Operating pressure and temperature of systems.
8. Details applicable to type of system specified.
9. Details of manhole and building entrances.
10. Other pertinent general information.

G. Pressures: Pressures listed in this section are gage pressure unless otherwise noted.

1.3 RELATED WORK

- A. Phasing of work: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Excavation, shoring and backfill: Section 31 20 00, EARTH MOVING and Section 31 20 11, EARTH MOVING (SHORT FORM).
- C. Concrete work: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Waterproofing of concrete structures: Section 07 12 00, BUILT-UP BITUMINOUS WATERPROOFING.
- E. Asbestos removal work: Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- F. Painting exposed steel and other surfaces: Section 09 91 00, PAINTING.
- G. Steel for trench and tunnel pipe supports: Section 05 50 00, METAL FABRICATIONS.
- H. Cathodic Protection of DDT Pre-Engineered Direct-Buried Systems: Section 26 42 00, CATHODIC PROTECTION

1.4 QUALITY ASSURANCE

- A. Approval by Contracting Officer is required of products or services of proposed manufacturers, suppliers and installers.
- B. For pre-engineered direct-buried systems, expansion joints and ball joints, submit certification that:
 1. Manufacturers regularly and currently manufacture the product.
 2. There is a permanent service organization trained by the manufacturer that will provide the required field supervision of the installation of the system or equipment. Submit name and address of the service organization.
- C. The manufacturer of pre-engineered direct-buried distribution system shall design the system to comply with the requirements of these specifications and is responsible for the complete product to be supplied, fabrication, witnessing installation and testing of the system. The complete design of the system shall be prepared, signed and sealed by a Professional Engineer employed by the system manufacturer.
- D. Products Experience Record:
 1. Pre-Engineered Direct-Buried Systems: Shall be manufactured by a company which specializes in these systems and which has been in this business for five or more years.

- E. Provide a complete installation with all necessary specialties, materials and equipment fully and properly connected and coordinated. Installation shall be fully operational upon completion of work defined and as phased.
- F. Apply and install systems, materials, equipment and specialties in accordance with manufacturer's instructions. Printed instructions shall be available at the site prior to and during construction.
- G. Materials, design, installation and workmanship shall conform to applicable local codes, and to national codes and standards as referenced in this specification.
- H. Manufactured Products:
 - 1. When two or more items serve the same function, they shall be products of one manufacturer.
 - 2. Manufacturers of assemblies of products, which include components made by others, shall assume complete responsibility for final assembled unit.
 - a. All components of an assembled unit need not be products of the same manufacturer.
 - b. Constituent parts that are alike shall be products of a single manufacturer.
 - c. Components shall be compatible with each other and with the total assembly for intended service.
 - 3. All systems and equipment shall be free from defects that would adversely affect the performance, maintainability, or appearance of individual components or overall assembly.
 - 4. Each product shall be designed for the service conditions specified for that product. If no conditions are specified, the product shall be suitable for the actual service conditions.
- I. Manufacturer's Identification: Components of equipment shall bear manufacturer's name or trademark and model number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment. Refer to Part 2 for requirements for pre-engineered direct-buried systems.
- J. Radiographic Testing of Welds: Weld examination methods and procedures and the interpretation of examining films shall conform to ASME B31.1. The testing firm shall utilize the proper film exposure, techniques, and penetrometer to produce density and geometric sharpness required for first quality film, and all radiographs shall be reviewed and interpreted and reading reports signed by not less than an American Society for Non-Destructive Testing (ASNT) Certified Level III Radiographer.

- K. Cathodic Protection: Required on drainable-dryable-testable (DDT) pre-engineered direct buried systems. Refer to Section 26 42 00, CATHODIC PROTECTION.

1.5 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submit information and materials under this section separate from information and materials submitted under other sections and mark "SUBMITTED UNDER Section 33 63 00, STEAM ENERGY DISTRIBUTION, GROUP ____."
- C. Submit all items listed under each group simultaneously (except for items that can only be submitted during construction and upon completion of construction).
1. Group I, Pre-Engineered Direct-Buried Systems:
- a. Certification that system manufacturer regularly and currently manufactures direct-buried systems, and that the designs of the system and equipment to be provided for this project conform to specification requirements. This certification shall be an original signed by a principal officer of the manufacturer.
 - b. Complete descriptions and drawings of design of system and materials of construction including component parts, assembly, carrier pipes, casing, anchors, pipe guides, pipe supports, expansion loops, manhole and building wall penetrations, end seals, leak plates, field installation instructions.
 - c. Manufacturer's data sheets on casing coatings. Provide test report that concludes that coating can withstand a minimum 96 hour test at 186 °C (366 °F) without disbonding from the steel jacket.
 - d. A detailed design layout of the system showing the size, type, and location of each component, the design of anchors and manhole and building wall penetrations, the design of the transition points to aboveground or other type systems. Also, if applicable, the type and details of the cathodic protection system including dielectric gaskets.
 - e. Manufacturer's quality assurance plan for fabrication, delivery, storage, installation and testing of system.
 - f. Certificate of Qualification from system manufacturer that the manufacturer's field representative regularly performs the specified duties of monitoring the installation of the system and is technically qualified and experienced in the installation of the

system and is authorized by the supplier to make and sign the daily reports specified herein.

- g. Manufacturer's data sheets and thickness of carrier pipe insulation.
 - h. Calculations approved and stamped by Professional Engineer demonstrating that allowable stress of piping will not be exceeded due to thermal expansion and that anchor forces and moments are not excessive. Calculations shall be performed by a finite-element, three dimensional analysis computer program. Final report shall show node stresses, forces, moments and displacements.
 - i. Design life calculations for cathodic protection system. These shall be approved and stamped by NACE-qualified corrosion engineer.
 - j. All drawings and calculations shall have Professional Engineer's stamp.
 - k. A proposed schedule of activities indicating when various items of work and tests are to be carried out and when quality control inspectors of the supplier will be present at the job site.
 - l. The daily written report from the manufacturer's representative at the job site during all stages of material delivery and construction.
 - m. Proposed changes in design due to unforeseen conflicts or interferences along the route of the system.
 - n. Upon completion of the work:
 - 1) Certificate of Compliance signed by principal officers of the manufacturer and the contractor certifying that the system has been installed in accordance with contract requirements.
 - 2) Operation and maintenance manual.
 - 3) As-built layout of system including all final elevations (hard copies and AutoCAD on CD).
2. Group II, Piping in Manholes, Concrete Tunnels, Open Areas:
- a. Pipe, valves, strainers and fittings.
 - b. Steam traps including orifice sizes, capacities.
 - c. Pipe hangers, brackets, supports, racks, anchors, guides.
 - d. Pipe hanger calculations.
 - e. Pipe insulation, jackets, adhesives and cements. Submit samples and technical information.
 - f. Layout drawings showing all piping, maintenance and operation access and sumps to scale.
3. Group III, Concrete Tunnels and Manholes:
- a. Tunnel and manhole plans, profiles, sections and details.
 - b. Manhole frames, covers and steps.

- c. Access doors and ladders.
 - d. Gravity ventilators and louvers.
 - e. Shop drawings for prefabricated tunnel sections and manholes.
 - f. Sumps and sump pumps.
4. Group V, Expansion Joints and Ball Joints:
- a. Joint locations, sizes, types, movements.
 - b. Anchor locations, design, forces and moments.
 - c. Certification that expansion joints conform to service requirements and to design standards of Expansion Joint Manufacturers Association.
 - d. Certification that representative of expansion joint manufacturer has reviewed the applications in detail and has taken no exception.
 - e. Certified test data on number of cycles to failure on similar units at project service conditions - bellows type and expansion compensators.
- D. Independent Weld Testing Firm for Carrier Piping in Pre-Engineered Direct-Buried Systems:
- 1. Certificate of Qualification of testing firm.
 - 2. Certificate of Acceptability of actual welds.
- E. Credentials of NACE-qualified firm for testing the cathodic protection. Refer to Section 26 42 00, CATHODIC PROTECTION.
- F. Proposed test procedures and samples of test data sheets for each required test, 30 days prior to the test date. Provide calibration data on all test instruments. Tests shall not begin until procedures have been approved.
- G. Test reports resulting from testing of installed systems, in booklet form showing all field tests performed to prove compliance with specified performance criteria.

1.6 STORAGE AND HANDLING

- A. Equipment and material placed on the job shall remain in the custody of the Contractor until final acceptance whether or not the Government has reimbursed the Contractor for the equipment and material.
- B. The Contractor is solely responsible for the protection of the equipment and material against damage from any source. Protect piping systems against entry of water and mud and all foreign substances by installing watertight protection on open ends at all times. Protect direct-buried system coatings from ultraviolet light (sunlight). Existing equipment worked on by the Contractor or in the Contractor's working area shall be under the custody and responsibility of the Contractor.
- C. All insulated piping systems exposed to water must be replaced with new systems.

- D. Place all damaged items in first class new operating condition or replace damaged items as determined and directed by the Contracting Officers Technical Representative (COTR), at no additional cost to the Government.

1.7 JOB CONDITIONS

- A. Phasing of demolition and construction shall be in accordance with the provisions of Section 01 00 00, GENERAL REQUIREMENTS, and as shown on steam distribution drawings.
- B. Interruption of Existing Service: Arrange, phase and perform work and provide temporary facilities, materials, equipment, and connections to utilities, to assure adequate steam and condensate return service for existing installations at all times. Only such absolutely necessary interruptions as may be required for making connections will be permitted, and only at such times when approval is obtained from COTR. Interruptions to steam and condensate service shall be only with prior approval, and be the minimum possible duration. All interruptions shall be as scheduled under Article "Phasing" of Section 01 00 00, GENERAL REQUIREMENTS as approved by the COTR.

1.8 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
- A-A-60005 NOT 1..... Frames, Covers, Grating, Steps, Sump And Catch Basin, Manhole
 - L-P-535E..... Plastic Sheet (Sheeting): Plastic Strip: Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate)
 - L-S-125B..... Screening, Insect, Nonmetallic
- C. Military Specifications (Mil. Spec.):
- MIL-S-901D..... Shock Tests. H.I. (High Impact) Shipboard Machinery, Equipment and Systems
- D. ASTM International (ASTM):
- A36/A36M-05..... Structural Steel
 - A47/A47M-99(2004)..... Ferritic Malleable Iron Castings
 - A53/A53M-06a..... Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - A105/A105M-05..... Carbon Steel Forgings for Piping Applications
 - A106/A106M-06a..... Seamless Carbon Steel Pipe for High-Temperature Service

A126-04 Gray Iron Castings for Valves, Flanges and Pipe Fittings

A134-96(2005) Pipe, Steel, Electric-Fusion(Arc)-Welded (Sizes NPS 16 and over)

A135/A135M-06 Electric-Resistance Welded Steel Pipe

A139/A139M-04 Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and over)

A167-99(2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip

A193/A193M-07 Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service

A194/A194M-07a Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

A197/A197M-00(2006) Cupola Malleable Iron

A216/A216M-07 Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.

A234/A234M-07 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

A240/A240M-07e1 Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications

A395/A395M-99(2004) Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

A536-84(2004) Ductile Iron Castings

B61-02 Steam or Valve Bronze Castings.

B209-06 Aluminum and Aluminum-Alloy Sheet and Plate

C411-05 Hot-Surface Performance of High-Temperature Thermal Insulation

C449/C449M-00 Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

C533-07 Calcium Silicate Block and Pipe Thermal Insulation

C547-06 Mineral Fiber Pipe Insulation

C552-03 Cellular Glass Thermal Insulation

C591-07 Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation

C655-04e1 Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe

C920-05 Elastomeric Joint Sealants

C1126-04 Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation

- C1136-06 Flexible, Low Permeance Vapor Retarders for Thermal Insulation
- D1784-06a Rigid Poly (Vinyl Chloride)(PVC) Compounds and Chlorinated Poly (Vinyl Chloride)(CPVC) Compounds
- D2310-06 Machine-Made "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe
- D2487-06 Soils for Engineering Purposes (Unified Classification System)
- D2996-01(2007)e1 Filament-Wound Fiberglass (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe
- E. American Society of Mechanical Engineers (ASME):
- B16.3-2006 Malleable Iron Threaded Fittings
- B16.5-2003 Pipe Flanges and Flanged Fittings NPS ½ - 24
- B16.9-2003 Factory-Made Wrought Buttwelding Fittings
- B16.11-2005 Forged Fittings, Socket-Welding and Threaded
- B31.1-2004 Code for Pressure Piping, Power Piping, with Amendments
- B31.9-2004 Code for Pressure Piping, Building Services Piping, with Amendments
- B40.100-2005 Pressure Gauges and Gauge Attachments
- Boiler and Pressure Vessel Code, Section VIII: 2007 Edition, with Amendments
- F. American Welding Society (AWS):
- AWS B2.1-00 Welding Procedure and Performance Qualification
- G. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS):
- SP45-03 By-Pass and Drain Connection Standard
- SP58-02 Pipe Hangers and Supports-Materials, Design and Manufacture
- SP69-03 Pipe Hangers and Supports-Selection and Application
- SP80-03 Bronze Gate, Globe, Angle and Check Valves
- H. National Fire Protection Association (NFPA):
- 255-06 Test of Surface Burning Characteristics of Building Materials
- I. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
- ASHRAE Handbook 2004 HVAC Systems and Equipment
- J. American Concrete Institute (ACI):
- 318-05 Building Code Requirements for Reinforced Concrete

- K. NACE International (Corrosion Engineers) (NACE):
RP0169-02..... Standard Recommended Practice, Control of External
Corrosion on Underground or Submerged Metallic
Piping Systems
- L. Expansion Joint Manufacturers Association (EJMA):
8th Edition-2003..... Standards of the Expansion Joint Manufacturers
Association
- M. American Association of State Highway and Transportation Officials
(AASHTO):
M300-03..... Inorganic Zinc Rich Primer
- N. Society for Protective Coatings (SSPC):
SP-10/NACE No. 2-2004.. Near White Blast Cleaning
- O. Unified Facilities Guide Specifications (UFGS):
UFGS 33 63 13..... Exterior Underground Steam Distribution System
(April 2006 or later)

PART 2 - PRODUCTS

2.1 PRE-ENGINEERED, FACTORY-FABRICATED, DIRECT-BURIED, DRAINABLE-DRYABLE-TESTABLE (DDT) SYSTEMS

- A. Complete steam and condensate piping system with carrier pipes, carrier pipe insulation with jackets and banding, air space, 6.35 mm (0.25 inch) thick steel casing, fusion-bonded epoxy casing coatings, cathodic protection, accessories. Do not locate condensate pipes in casings (conduits) that contain steam pipes.
- B. Design Pressure and Temperature: All components of system shall be suitable for carrier pipe pressures and temperatures as follows:
1. Steam System: 1000 kPa (150 psi); 185 °C (366 °F).
 2. Condensate System: 345 kPa (50 psi); 154 °C (310 °F).
- C. Description of System Design: Refer to Part 1, "DEFINITIONS".
- D. Steam Carrier Pipes: Refer to Paragraph, "STEAM PIPING".
1. No piping joints allowed in factory-fabricated straight sections of pre-engineered direct-buried systems.
 2. Factory-fabricated direct-buried piping sections that are a portion of an expansion loop or bend shall have all welded joints 100% radiograph inspected.
- E. Condensate Carrier Pipes: Refer to Paragraph, "STEAM CONDENSATE PIPING".
1. No piping joints allowed in factory-fabricated straight sections of pre-engineered direct-buried systems.
 2. Factory-fabricated direct-buried piping sections that are a portion of an expansion loop or bend shall have all welded joints 100% radiograph inspected.

F. Carrier Pipe Insulation:

1. Conform to minimum thickness and type of insulation listed in Tables 1 and 2 below as required for service temperature in carrier pipe as listed below.
2. Steam temperature is 170°C (338°F), steam pressure is 689kPa (100psi). Pumped condensate temperature is 93 °C (200 °F). Drip return temperature is 100 °C (212 °F).
3. Allowable Carrier Pipe Insulation Type and Minimum Insulation Thickness:

TABLE 1 Minimum Pipe Insulation Thickness mm (inches) For Steam 110 to 2800 kPa (16 to 408 psi) gage			
Nominal Pipe Diameter mm (inches)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp
25 (1)	50 (2)	65 (2 1/2)	100 (4)
40 (1 1/2)	50 (2)	65 (2 1/2)	100 (4)
50 (2)	65 (2 1/2)	85 (3 1/2)	110 (4 1/2)
65 (2 1/2)	65 (2 1/2)	85 (3 1/2)	110 (4 1/2)
80 (3)	75 (3)	100 (4)	125 (5)
100 (4)	75 (3)	100 (4)	125 (5)
125 (5)	75 (3)	100 (4)	125 (5)
150 (6)	85 (3 1/2)	110 (4 1/2)	135 (5 1/2)
200 (8)	85 (3 1/2)	110 (4 1/2)	135 (5 1/2)
250 (10)	100 (4)	125 (5)	150 (6)
300 (12)	100 (4)	125 (5)	150 (6)
350 (14)	100 (4)	125 (5)	150 (6)
400 (16)	100 (4)	125 (5)	150 (6)
450 (18)	100 (4)	125 (5)	150 (6)

Notes: Insulation listed has passed the 96-hour boiling water test. Pipes smaller than 25 mm (1 inch) shall have same insulation thickness as 25 mm (1 inch) pipe.

TABLE 2 Minimum Pipe Insulation Thickness mm (inches) For Steam Less than 110 kPa (16 psi) gage, Condensate Return			
Nominal Pipe Diameter mm (inches)	MPT-PF MPT-PC	Delta	Thermo-12 Super Caltemp
25 (1)	40 (1 1/2)	50 (2)	75 (3)

TABLE 2 Minimum Pipe Insulation Thickness mm (inches) For Steam Less than 110 kPa (16 psi) gage, Condensate Return			
Nominal Pipe Diameter mm (inches)	MPT-PF MPT-PC	Delta	Thermo-12 Super Caltemp
40 (1 1/2)	40 (1 1/2)	50 (2)	75 (3)
50 (2)	40 (1 1/2)	50 (2)	75 (3)
65 (2 1/2)	40 (1 1/2)	50 (2)	75 (3)
80 (3)	50 (2)	65 (2 1/2)	85 (3 1/2)
100 (4)	50 (2)	65 (2 1/2)	85 (3 1/2)
125 (5)	50 (2)	65 (2 1/2)	85 (3 1/2)
150 (6)	65 (2 1/2)	80 (3)	110 (4.5)
200 (8)	65 (2 1/2)	80 (3)	110 (4.5)
250 (10)	80 (3)	100 (4)	125 (5)
300 (12)	80 (3)	100 (4)	125 (5)
350 (14)	80 (3)	100 (4)	125 (5)
400 (16)	80 (3)	100 (4)	125 (5)
450 (18)	80 (3)	100 (4)	125 (5)

Notes: Insulation listed has passed the 96-hour boiling water test which indicates that satisfactory performance in underground service can be expected.

Pipes smaller than 25 mm (1 inch) shall have the same insulation thickness as required for 25 mm (1 inch) pipe.

"Delta" is available from Rockwool, Leeds, AL.

"MPT" is available from Mineral Products of Texas, Houston, TX.

"Thermo-12" and "Super Caltemp" is available from Industrial Insulation Group, Brunswick, GA.

4. Insulation Banding and Jacket: Stainless steel bands and clips, at least 13 mm (0.5 inches) wide, ASTM A-167 (304 stainless steel), maximum spacing 460 mm (18 inches). A minimum of two bands is required for each 1300 mm (4 foot) section of insulation. Vinyl-coated fiberglass scrim jacket, Fed. Spec. L-S-125, Type II, Class 2, with 18 x 16 mesh (number of filaments per inch) and made of 0.335 mm (0.013 inches) diameter vinyl-coated fibrous glass yarn. Install bands over the jacket to secure the insulation to the carrier pipe.

G. Casing: Smooth-wall steel, electric resistance welded, conforming to ASTM A134, ASTM A135, or ASTM A139. Plastic casings are not permitted. Use eccentric connectors as necessary between casing sections to provide

continuous gravity drainage in bottom of casing between manholes and between manholes and buildings.

Casing Diameter mm (in.)	Minimum Thickness mm (in.)
150 - 1170 (6 - 46)	6.35 (0.250)

- H. Casing End Seal Plates with Vents and Drains: ASTM A36 steel, minimum thickness 9.5 mm (0.375 inches) for casings up thru 300 mm (12 inches) diameter and 13 mm (0.5 inches) for casings over 300 mm (12 inches) diameter. Provide 25 mm (one inch) drain at the bottom and vent at the top. Construct with threaded steel half couplings. Install threaded brass plugs in drains. Install vent riser pipes, ASTM A53, Schedule 40, galvanized, extending through top of manhole and terminate 300 mm (12 inches) above grade with 180-degree bend.
- I. Gland Seals: Not permitted because of the possibility of water entering the system thru the gland seal from a flooded manhole.
- J. Air Space: Provide continuous 25 mm (one inch) minimum air space between carrier pipe insulation and casing.
- K. Casing Coating: Dual layers of fusion-bonded epoxy, inner green-colored layer minimum thickness 0.5 mm (0.020 inches), outer black-colored layer minimum thickness 0.25 mm (0.010 inches). Rated by coating manufacturer for continuous service for at least 25 years at minimum temperature of 110 °C (230 °F) and having a coefficient of expansion similar to that of steel. Coating shall be applied in accordance to recommendations of coating manufacturer including surface preparation. Factory-inspect for holidays and make repairs as necessary.
- L. Coating of End Plates and Casing (Conduit) Sections Extending in Manholes: Zinc-rich coating that conforms to AASHTO M300, Type IA except that volatile organic compounds shall not exceed 0.34 kg per liter (2.8 pounds per gallon). The zinc rich coating shall be applied in accordance with the recommendations of the coating manufacturer including surface preparation. No additional top coat shall be applied.
- M. Carrier Pipe Guides and Supports: Maximum spacing 3000 mm (10 feet) on centers, no more than 1500 mm (5 feet) from pipe ends, minimum of three guides per elbow section. Designed to permit thermal expansion without damage, provide proper pipe guiding and support, and to allow horizontal movement in two directions as necessary at expansion loops and bends. Design of guides and supports must permit continuous drainage of water in bottom of casing. Pipe insulation shall extend thru the pipe guides and supports and be protected by steel sleeves. Design of guides and supports shall be such that no metal-to-metal contact exists between the casing and

the carrier pipe. Insulation or non-metallic material used to ensure no metal to metal contact shall be designed to not be compressed by the weight of the carrier pipe when full of water.

- N. Anchor Plates: ASTM A36 steel, welded to carrier pipe and casing, 13 mm (0.5 inches) minimum thickness, passages for air flow and water drainage thru the annular air space in the system. Coated with same coating material as the casing. Locate 900 to 1500 mm (3 to 5 feet) from piping entrance to manhole or building wall. Walls of manholes and buildings cannot be utilized as anchor points.
- O. Field Connection of Casing Sections: Steel section conforming to casing specification, welded to casing sections, coated on all surfaces with system manufacturer's coating field repair compound, and covered with a 1.3 mm (0.05 inch) minimum thickness polyethylene shrink sleeve designed for a service temperature exceeding 80 °C (176 °F).
- P. Manhole and Building Wall Penetrations: Provide steel leak plates welded to wall sleeves or to casings. Where wall sleeve is utilized, allow sufficient annular space between the sleeve and the casing and install a watertight EPDM Link-Seal (Thunderline Corp) or equal, rated for 121 °C (250 °F) minimum. Manhole and building walls cannot be used as anchor points.
- Q. Cathodic Protection: Provide sacrificial anode type system with dielectric isolation devices and test stations for all systems. Design system for 25 years service, assume two percent bare metal. System shall comply with NACE RP0169 and shall conform to Section 26 42 00, CATHODIC PROTECTION.
- R. Manufacturer's Identification: Provide embossed brass or stainless steel tag hung by a brass or stainless steel chain at each end of each conduit or insulated piping in the manholes and buildings. The tag shall identify system manufacturer's name, date of installation, government contract, and manufacturer's project number.
- S. Branch Piping Connections: All branch piping connections must be located in manholes.
- T. Manufacturers: Perma-Pipe, Rovanco, Thermacor, or equal.

2.2 MANHOLES

- A. Concrete Construction: Reinforced concrete conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, not less than 200 mm (8 inches) thick. Pour monolithically where possible. Place waterproof membrane as specified in Section 07 12 00, BUILT-UP BITUMINOUS WATERPROOFING, between mud slab and bottom concrete slab, and continue up sides to top of sidewalls. Joints between manhole walls and conduit casings or concrete trench sections

shall be watertight. Steel manholes or prefabricated concrete manholes are not permitted.

- B. Manhole Access Frames, Covers and Steps: Provide each manhole with cast iron manhole frames and solid covers, not less than 700 mm (28 inch) clear openings, Fed. Spec. A-A-60005. Unless otherwise shown on the drawings, frames and covers shall be as follows:

1. For non-traffic applications:

Frame - Type IV, Size 28

Cover - Type E, Size 28, cast identification "STEAM".

2. For traffic applications:

Frame - Type I, Style A, Size 27A

Cover - Type A, Size 27A, cast identification "STEAM".

3. Manhole steps: Standard, cast-iron, Fig. 19, Fed. Spec. A-A-60005.

- C. Drainage: Provide as shown on drawings. Provide a 610 mm (24 inch) square by 610 mm (24 inch) deep sump pit in each manhole where indicated on drawings.

2.3 STEAM CARRIER PIPING

- A. Pipe: Steel; seamless, ASTM A53, Grade B or ASTM A106, Grade B; electric resistance welded ASTM A53, Grade B; Schedule 40. Standard weight permitted for pipe sizes 300 mm (12 inches) and above. Grade F, furnace butt-welded pipe, is not permitted.

- B. Joints:

1. In trenches and direct-buried systems: Butt-weld except socket-weld for pipe sizes two-inches and below. Manufacturer's standard sliding gasketed joints permitted between sections of WSL pre-engineered direct-buried systems. No joints allowed in factory-fabricated straight sections of pre-engineered direct-buried systems. Factory-fabricated direct-buried piping sections that are a portion of an expansion loop or bend shall have all welded joints 100% radiograph inspected. All radiographs shall be reviewed and interpreted by a American Society for Non-Destructive Testing (ASNT) Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. Dye penetrant testing may be utilized for pipe sizes 50 mm (2 inches) and below.
2. In tunnels, manholes and open areas: Butt-weld pipe sizes 65 mm (2-1/2 inches) and above; thread or socket-weld pipe sized 50 mm (two inches) and below.

- C. Fittings:

1. Butt-Welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe. All elbows shall be long radius unless

otherwise indicated. Tees shall be full size or reducing as required, having interior surfaces smoothly contoured.

2. Threaded Joints: Malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 pound) class.
3. Socket-Welded Joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.
- D. Flanges and Bolts: Weld neck, ASME B16.5, forged steel, ASTM A105. Pressure class 1025 kPa (150 psi). Bolts shall be high strength ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.
- E. Unions: On pipe 50 mm (two inches) and smaller, threaded, malleable iron or steel, 2050 kPa (300 psi) class.

2.4 STEAM CONDENSATE CARRIER PIPING

- A. Pipe: Seamless, ASTM A53, Grade B or ASTM A106, Grade B; electric resistance welded ASTM A53, Grade B; Schedule 80. Grade F, furnace butt-welded, pipe is not permitted.
- B. Joints:
 1. In Trenches and direct-buried systems: Butt-weld except socket-weld is required for pipe sizes 50 mm (two inches) and below. Manufacturer's standard sliding, gasketed joints permitted between factory-fabricated sections of direct buried WSL system. No joints allowed in factory-fabricated straight sections of pre-engineered direct-buried systems. Factory-fabricated direct-buried piping systems that are a portion of expansion loops or bends shall have all welded joints 100% radiograph inspected. All radiographs shall be reviewed and interpreted by a ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. Dye penetrant testing may be utilized for pipe sizes 50 mm (2 inches) and below.
 2. In Tunnels, Manholes and Open Areas: Butt-weld pipe sizes 65 mm (2-1/2 inches) and above; thread or socket-weld for pipe sizes 50 mm (two inches) and below.
- C. Fittings:
 1. Welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
 2. Threaded Joints: Malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
 3. Socket-Welded Joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.
- D. Unions (Except in Trenches): On piping 50 mm (two inches) and under, 2050 kPa (300 psi) malleable iron or steel.

E. Flanges: Weld neck ASME B16.5, forged steel, ASTM A105, 1025 kPa (150 psi).

2.5 EXPANSION LOOPS AND BENDS

A. Stresses shall be less than the maximum allowable stress in the Power Piping Code (ASME B31.1). Submit shop drawings and stress and anchor force calculations for all loops and bends. Show locations of all anchors, guides and supports. Base calculations on 1000 kPa (150 psi) and 185 °C (366 ° F) for steam line loops and bends and 345 kPa (50 psi) and 154 °C (310 °F) for condensate return line loops and bends.

2.6 EXPANSION JOINTS

- A. Factory built devices, inserted in the pipelines, and designed to absorb axial cyclical pipe movement that results from thermal expansion and contraction. Provide factory-built or field-fabricated guides located along the pipelines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
- B. Minimum Service Requirements:
1. Pressure Containment:
 - a. Steam Service 214-850 kPa (31-125 psi): Rated 1025 kPa (150 psi) at 186 °C (366 °F).
 - b. Condensate Service: Rated 690 kPa (100 psi) at 154 °C (310 °F).
 2. Number of Full Reverse Cycles without failure: Minimum 1000.
 3. Movement: As shown on drawings plus recommended safety factor of manufacturer.
- C. Manufacturing Quality Assurance: Conform to EJMA Standards.
- D. Bellows - Internally Pressurized Type:
1. Multiple corrugations of ASTM A240, Type 304 or 321 stainless steel.
 2. Internal stainless steel sleeve entire length of bellows.
 3. External cast iron equalizing rings for services exceeding 340 kPa (50 psi).
 4. Welded ends.
 5. Design shall conform to standards of EJMA and ASME B31.1.
 6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
 7. Integral external cover.
- E. Bellows - Externally Pressurized Type:
1. Multiple corrugations of ASTM A240, Type 304 stainless steel.
 2. Internal and external guides integral with joint.
 3. Design for external pressurization of bellows to eliminate squirm.

4. Welded ends.
 5. Conform to the standards of EJMA and ASME B31.1.
 6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
 7. Integral external cover and internal sleeve.
- F. Slip-Type Joints:
1. Steel construction, except guides.
 2. Base with integral anchor.
 3. Internally and externally guided steel slip, chrome plated to reduce corrosion, ground to reduce friction.
 4. Guides shall be non-ferrous, non-corroding, low friction, designed to prevent scoring or binding of the slip.
 5. Welded ends.
 6. Limit stop to prevent slip disengagement if pipe anchor fails.
 7. Semi-plastic, self-lubricating injectable packing contained between sealing rings.
 8. Injection devices to allow addition of packing under full line pressure. Provide one-year supply of packing.
 9. Threaded connection at bottom, one-inch minimum, for drain or drip point.
- G. Expansion Compensators:
1. Permitted for condensate lines where pipe expansion is within limits of compensator.
 2. Corrugated bellows, externally pressurized, stainless steel or bronze.
 3. Internal guides and anti-torque devices.
 4. Threaded ends.
 5. External shroud.
 6. Conform to standards of EJMA.
- H. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.
- I. Guides: Provide factory-built guides along the pipeline to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15% of the axial force that will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings. Guide locations must conform to recommendations of expansion joint manufacturer and EJMA.

2.7 BALL JOINTS

- A. Factory-built devices, inserted in pipe line offsets in groups of two or three as shown to absorb cyclical pipe movement which results from thermal expansion and contraction.
- B. Minimum Service Requirements: Rated 1725 kPa (250 psi), 232 °C (450 °F), continuous on steam and condensate.
- C. Quality Assurance: Submit independent certification that similar units have passed the following tests with no leaks.
 - 1. Low Pressure Leakage Test: Minimum 40 kPa (6 psi) saturated steam for 60 days.
 - 2. Life Cycle Flex Test: Minimum 8000 flex cycles at 1725 kPa (250 psi) saturated steam.
 - 3. Thermal Cycling Test: Minimum 100 cycles from atmospheric pressure to operating pressure and back to atmospheric pressure with saturated steam.
 - 4. Environmental Shock Test: In accordance with MIL-S-901.
 - 5. Vibration Test: Test for 170 hours on each of three mutually perpendicular axes at 25 to 125 HZ; 1 to 2 mm (0.05 to 0.10 inch) double amplitude on a single ball joint and on a three ball joint offset.
- D. Construction:
 - 1. Cast or forged carbon steel, weld ends.
 - 2. Standard weight pipe wall thickness.
 - 3. Conform to ASME B31.1.
 - 4. Provide minimum angular movement capability of 15 degrees and 360 degrees rotational movement.
 - 5. Non-asbestos gaskets.
 - 6. Packing injection devices, if provided, shall allow injection under full line pressure. Provide one-year supply of packing.

2.8 VALVES

- A. Valves for particular services are generally specified as Type Numbers. The Type Numbers are defined below. All valves of the same type shall be the products of a single manufacturer and shall comply with MSS SP45, MSS SP80 and ASME B31.1. Design valves for the service fluids and conditions. Pressure - temperature ratings listed are minimum requirements. Packing and gaskets must be asbestos-free.
- B. Valve Type Designations:
 - 1. Gate Valves:
 - a. Type 101: Cast steel body ASTM A216 WCB, rated 1025 kPa (150 psi) at 260 °C (500 °F), 11-1/2 to 13 percent chromium stainless steel

flexible wedge and hard faced (stellite) or nickel-copper alloy seats, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet.

- 1) Provide factory installed globe valved bypass on all steam valves larger than 80 mm (3 inches). Conform to MSS SP45.
 - 2) Drill and tap bosses for connection of drains where shown. Conform to MSS SP45.
- b. Type 102: Not used.
 - c. Type 103: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze faced wedge and seats, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
 - d. Type 104: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze wedges and Monel or stainless steel seats, threaded ends, rising stem, union bonnet.
 - e. Type 105: Not used.
 - f. Type 106: Forged steel body ASTM A105, rated for 2050 kPa (300 psi) at 216 °C (420 °F) minimum (Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi)), hardened stainless steel or stellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.
2. Globe valves:
- a. Type 201: Cast steel body ASTM A216 WCB, rated 1025 kPa (150 psi) at 260 °C (500 °F), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown to conform to MSS SP45.
 - b. Type 202: Not used.
 - c. Type 203: Cast iron body ASTM A126, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
 - d. Type 204: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.
3. Check valves:
- a. Type 401: Cast steel body ASTM A216, swing-type, rated for 1025 kPa (150 psi) at 260 °C (500 °F), stainless steel or stainless steel -

- faced disc and seat, 1025 kPa (150 psi) ASME flanged ends, bolted cover, renewable disc.
- b. Type 402: Not used.
 - c. Type 403: Cast iron body ASTM A126 Class B, swing-type, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc and seat, 850 kPa (125 psi) ASME flanged ends, bolted cover, renewable disc and seat.
 - d. Type 404: Bronze body ASTM B61, swing-type, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze disc, threaded ends, regrinding disc.
4. Ball valves: Reduced port permitted for bypass (throttling) service, full port required for all other services, one-fourth turn to open.
- a. Type 501: Not used.
 - b. Type 502: Bronze body, rated for 1025 kPa (150 psi) at 185 °C (365 °F), 1725 kPa (250 psi) at 121 °C (250 °F); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, one-fourth turn to open.
 - c. Type 503: Not used.
 - d. Type 504: Carbon steel or ASTM A536 ductile iron body, saturated steam service, rated for 1030 kPa (150 psi), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, 1025 kPa (150 psi) ASME flanged ends. Manufacturer: American, Worcester, or equal.
5. Butterfly valves:
- a. Type 601: Ductile iron body ASTM A395 or A536, wafer style, rated for 850 kPa (125 psi), 100 °C (212 °F), bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and larger, ratchet handle operator for smaller pipe sizes.
 - b. Type 602: Triple-offset, lug or flanged type, carbon steel body, steam service, rated for 1025 kPa (150 psi) at 260 °C (500 °F), stainless steel nitrided disc, stellite seat, stainless steel shaft, stainless steel/graphite-laminated seal ring, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and larger, ratchet handle operator for smaller pipe size valves. Manufacturer: Flowseal MS (Crane Co.) or equal.
- C. Valve Applications (Steam Lines):
- 1. Gate valves, 50 mm (two inches) and under: Type 106.
 - 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 101.

3. Globe valves, 50 mm (two inches) and under: Type 204.
4. Globe valves, 65 mm (2-1/2 inches) and above: Type 201.
5. Check valves, 50 mm (two inches) and under: Type 404.
6. Check valves, 65 mm (2-1/2 inches) and above: Type 401.
7. Ball valves, 50 mm (two inches) and under: Type 502
8. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
9. Butterfly valves, all sizes: Type 602.

D. Valve Applications (Condensate Lines):

1. Gate valves, 50 mm (two inches) and under: Type 104.
2. Gate valves, 65 mm (2 1/2 inches) and above: Type 103.
3. Globe valves, 50 mm (two inches) and under: Type 204.
4. Globe valves, 65 mm (2 1/2 inches) and above: Type 203.
5. Check valves, 50 mm (two inches) and under: Type 404.
6. Check valves, 65 mm (2 1/2 inches) and above: Type 403.
7. Ball valves, 50 mm (two inches) and under: Type 502.
8. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
9. Butterfly valves, all sizes: Type 601.

2.9 STEAM PRESSURE REDUCING VALVES

- A. Type: Single-seated, diaphragm operated, spring-loaded, steam pilot-controlled, normally closed, packless, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.
- B. Service: Provide controlled reduced pressure to steam piping systems. Design for saturated steam at pressures shown on drawings.
- C. Performance: Pressure control shall be smooth, continuous. Maximum 10 percent deviation from set pressure over an 18/1 turndown. Refer to schedules on drawings for flow and pressure requirements. Maximum flow capability of each valve shall not exceed capacity of downstream safety valves.
- D. Construction:
 1. Main Valve - Pipe Sizes 50 mm (2 inches) and under: Cast iron body rated for 1725 kPa (250 psi), threaded ends. Valve plug and seat shall be replaceable, Type 316 stainless steel or Monel. Stainless steel stem.
 2. Main Valves - Pipe Sizes Above 50 mm (2 inches): Cast steel body rated for 1025 kPa (150 psi) ASME flanged ends, or cast iron body 1725 kPa (250 psi) ASME flanged ends. Valve plug and seat shall be replaceable, Type 316 stainless steel or Monel. Stainless steel stem.
 3. Pilot Valve: Valve plug and seat shall be replaceable, stainless steel or Monel.

2.10 STEAM TRAPS

- A. Apply at steam line drip points.
- B. Inverted bucket type with thermostatic vent in bucket, except closed-float-thermostatic on discharge side of pressure reducing stations. Each type furnished by a single manufacturer. Select the traps for pressures and capacities as shown or required. Fixed orifice or venturi type traps are not permitted.
- C. Cast iron or stainless steel bodies. Construction shall permit ease of removal and servicing working parts without disturbing connecting piping.
- D. Stainless steel floats. Hardened chrome steel valves. Stainless steel mechanisms. Bi-metallic air vent on inverted bucket traps.
- E. Provision for Future Trap Performance Monitoring System: All traps shall include ports for future installation of monitoring devices such as Armstrong "Steam Eye" or equal. To facilitate future removal of plugs, remove plugs, install Teflon tape on the threads, and reinstall the plugs.
- F. Factory-Packaged Trap Station: As an option for drip points requiring isolating valves, strainer, trap, and valved test connection, provide factory-packaged trap station including these features. Manufacturer: Armstrong or equal.
- G. Identification: Label each trap at the factory with an identification number keyed to the contract drawings. Label shall be a metal tag permanently attached to the trap.
- H. Install a ¼" test plug between the outlet of all steam taps and inlet of downstream stop valves.

2.11 STRAINERS, Y-TYPE

- A. Provide as shown on steam and condensate piping systems.
- B. Type: Open-end removable cylindrical screen; threaded blow-off connection.
- C. Construction:
 - 1. Steam Service to 1025 kPa (150 psi) and at Drip Traps: Rated for minimum 1025 kPa (150 psi) saturated steam. Rated for 1025 kPa (150 psi) ASME flanged ends, cast steel, for pipe sizes above 50 mm (two inches). Cast iron or bronze, rated for 1725 kPa (250 psi) saturated steam, threaded ends, for pipe sizes 50 mm (two inches) and under.
 - 2. Condensate Service: Rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG. Provide 850 kPa (125 psi) ASME flanged ends, cast iron, for pipe sizes above 50 mm (two inches). Provide cast iron or bronze, threaded ends, for pipe sizes 50 mm (two inches) and under.
- D. Screen: Monel or stainless steel, free area not less than 2-1/2 times flow area of pipe. Diameter of openings shall be 1.3 mm (0.05 inch) or less on steam service and 1.5 mm (0.06 inch) or less on water service.

- E. Accessories: Gate type valve and quick-couple hose connection on all blowoff connections.

2.12 SAFETY VALVES AND VENT CONNECTORS

- A. Safety valves shall conform to the requirements of ASME Boiler and Pressure Vessel Code (Section VIII, Unfired Pressure Vessels) and be approved by the National Board of Boiler and Pressure Vessel Inspectors.
- B. Relieving capacity shall not be less than that shown on the drawings with a pressure rise above set pressure not to exceed 10 percent of set pressure.
- C. Provide at the discharge of each safety valve a special flexible connector attached to the vent pipe and the safety valve. Multi-ply stainless steel bellows, full internal pipe liner, protective exterior shroud, drip catching configuration with drain, designed to prevent blow back of steam into space, pressure tested at not less than 100 kPa (15 psi). Drip pan ells not allowed in tunnels or constricted spaces because of "blow-back" of steam from the drip pan ell openings.

2.13 PRESSURE GAGES

- A. Provide gages immediately downstream of each steam line isolation valve, before and after each steam pressure reducing station and where shown on the drawings.
- B. Construction:
1. Case: Solid armored front between measuring element and dial, blowout back, bottom connection, phenol turret type.
 2. Dial: Non-corrosive, 110 mm (4-1/2 inch) diameter face with black markings on white background.
 3. Measuring Element: Bourdon tube designed for service. Provide bellows for pressure ranges under 100 kPa (15 psi).
 4. Movement: Stainless steel, rotary.
 5. Pointer: Micrometer adjustable, black color.
 6. Window: Plastic.
 7. Liquid Filled Gages: Provide at outlet of all pumps.
- C. Accuracy: ANSI B40.100, Grade 2A, 1/2 percent, on all gages; except Grade A, one percent permitted on diaphragm actuated gages, liquid filled gages, and compound gages.
- D. Accessories:
1. Red set hands on gages located at automatic pressure regulator valve outlets.
 2. Needle valve or gage cock rated for the service.
 3. Syphon on all steam gages.
 4. Overload stop on all pressure gages.

E. Ranges: Except where otherwise shown on the drawings, pressure ranges shall be as follows:

SERVICE	RANGE
Steam to 15 psi	0 to 30 psi
Steam to 59 psi	0 to 100 psi
Steam above 59 psi	0 to 200 psi
Condensate Pump Discharge	0 to 100 psi

2.14 THERMOMETERS, PIPE OR TANK-MOUNTED

A. Thermometer locations are shown on the drawings.

B. Construction:

1. Industrial type, separable well and socket, union-connected.
2. Scales: Red-reading mercury combination Fahrenheit/Celsius. 220 mm (nine inches) long.
3. Case: Corrosion resistant with glass or plastic front.
4. Form: Straight or back form except those located more than 2100 mm (seven feet) above floor shall be adjustable angle.
5. Wells: Sized to suit pipe diameter without restricting flow, or provide oversized pipe at well location. Snug sliding fit between socket and well.
6. Accuracy: One percent of scale range.
7. Range: 0 to 150 °C, 30 to 300 °F.

2.15 PIPE HANGERS AND SUPPORTS

A. Applies to all piping not in factory-fabricated direct-buried system. All systems shall be completely supported. Arrange supports so that all loads due to weight, thermal expansion, seismic shock (if applicable), and pressure are transferred from the support system to the structure. The design and location of supports shall at all times prevent excessive forces, moments, and stresses from being imposed on the equipment, structure, supported system, and supports. Heated systems generally require resilient or roller/slide supports.

B. Standards: Comply with recommendations and requirements of MSS SP-58, MSS SP-69, ASME B31.1.

C. Design:

1. Components: Factory-built products of a manufacturer whose principle business is pipe supports. All components must have published load ratings. For concrete trenches, non-factory built products that comply with details shown on the contract drawings may also be utilized.

2. Selection of Components: Types, sizes, locations, and spacing must conform to MSS SP-69. Horizontal steam and condensate piping shall have roller or slider supports. Supports at risers shall be spring type that accommodates the thermal expansion. Contract drawings may show locations and types of supports including rollers and springs, and may also show special supports including anchors, guides and braces. Rigid supports such as clevises are generally not shown. Technical personnel employed by the support manufacturer shall do final selection of components, locations and sizes. If equipment and piping arrangement differs from that shown on the drawings, support locations and types shall be revised at no cost to the government. Locate supports to permit removal of valves and strainers from pipelines without disturbing supports.
3. Spring Hangers: Provide on all systems subject to vertical movement.
4. Roller Hangers and Sliding Supports: Provide on all systems subject to horizontal movement due to thermal expansion except when long hanger rods permit sufficient horizontal movement. If vertical angle of hanger rod exceeds four degrees, rollers or sliders are required.
5. Calculations: Calculate loads for all supports. On systems utilizing variable spring supports, determine the loads at each support by calculating the forces and moments throughout the system.
6. Deflection of Supported Systems: Vertical deflection due to system weight shall not exceed 2.5 mm (0.1 inch) between supports when system is filled with fluid normally carried.
7. All support assemblies from above shall include threaded connections that permit vertical position adjustment.
8. Layout Drawings and Identification of Hanger Parts: Prepare drawings showing each hanger location and identifying each hanger by number. Prepare individual drawing for each hanger assembly showing all components, sizes, calculated loadings. Provide identification tags, on each hanger part, keyed to the layout drawings.
- D. Upper Attachments to Structure: MSS SP-58, Type 18, 20, 21, 22, 23, 29, and 30.
- E. Roller Supports: MSS SP-58, Types 41, 43, and 46. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.
- F. Variable Spring Support Assembly: MSS SP-58, Type 51 variable spring, Type 3 pipe clamp or Type 1 clevis. Type 53 variable spring trapeze may also be used. Locate Type 51 variable spring within 300 mm (one foot) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.

G. Spring Cushion Support Assembly:

1. Double Rod Assembly: MSS SP-58, Type 41 and 49.
2. Single Rod Assembly: MSS SP-58, Type 48 spring cushion, Type 3 pipe clamp or Type 1 clevis. Locate spring cushion within 300 mm (one foot) above pipe attachment.

H. Clevis Supports: MSS SP-58, Type 1.

I. Wall Brackets: MSS SP-58, Type 31, 32, and 33.

J. Pipe Stands: MSS SP-58, Type 38.

K. Riser Clamp: MSS SP-58, Type 42.

L. Alignment Guides: Construct guides of welded steel as shown to restrain movement perpendicular to the long axis of the piping. If not shown, provide steel spider clamped to pipe, enclosed within steel sleeve that is bolted or welded to structural support. Spider-type guide shall be a standard manufactured product. Design to withstand lateral force equal to minimum of 15 percent of anchor loading.

M. Trapeze Supports: May be used where pipes are close together and parallel. Construct with structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with u-bolts.

N. Pipe covering protection saddles: MSS SP-58, Type 39. Provide at all support points on insulated pipe except where Type 3 pipe clamp is provided.

O. Sliding Supports: MSS SP-58, Type 35. Welded steel attachments to pipe and structure with Teflon or graphite sliding surfaces bonded to the attachments. Provide steel guides, except at expansion bends, to prevent lateral movement of the pipe.

P. Pipe Racks and miscellaneous supports: Provide as shown. Construct of standard structural steel shapes, ASTM A36. Manufactured strut systems are acceptable if they have the required load-carrying ability.

Q. All supports, including all structural steel, in trenches and manholes shall be hot-dip galvanized as specified in Section 05 50 00, METAL FABRICATIONS.

2.16 PIPE ANCHORS

Provide as shown. Construct with all welded steel, ASTM A36.

2.17 INSULATION MATERIALS (IN MANHOLES, TUNNELS, OPEN AREAS)

A. Calcium Silicate Insulation:

1. Preformed Piping Insulation: ASTM C533, Type I.
2. Blocks: ASTM C533, Type I.

3. Fitting Insulation: ASTM C533, with polyvinyl chloride, Fed. Spec. L-P-535, Type II Grade GU, and Type III, premolded fitted covering 0.5 mm (0.020 inches) thick.
- B. Fiberglass Insulation:
1. Preformed Piping Insulation: ASTM C547, 230 °C (450 °F).
 2. Fitting Insulation: ASTM C547, 230 °C (450 °F), with polyvinyl chloride, Fed. Spec. L-P-535, Type II Grade GU, and Type III, premolded fitted covering 0.5 mm (0.020 inches) thick.
- C. Rigid Closed Cell Phenolic Foam: Preformed Piping Insulation: ASTM C1126, Type III, Grade 1, 121 °C (250 °F).
- D. Cellular Glass Insulation: Preformed Piping Insulation: ASTM C552.
- E. Insulating and Finishing Cements: Best grade recommended by printed instructions of manufacturer for the type of insulation system and service conditions. Conform to ASTM C449.
- F. Insulation Bands: Minimum 12 mm (1/2 inch) wide by 0.4 mm (0.015 inch) thick ASTM A167 stainless steel.
- G. Aluminum Jackets: Minimum 0.4 mm (0.016 inch) thick aluminum, ASTM B209, 3003 alloy, H-14 temper, with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory fabricated to match material and construction of the straight run jackets. Factory fabricated stainless steel bands shall be furnished and installed on all circumferential joints. Bands shall be 20 mm (0.75 inch) wide on 450 mm (18 inch) centers. Bands shall be applied with manufacturers recommended sealant. Entire system shall be watertight.
- H. All-Service Jackets: White kraft bonded to 0.025 mm ((0.001 inch) thick aluminum foil, fiberglass reinforced, pressure sensitive adhesive closure. Beach puncture 50 units, suitable for painting without sizing. Comply with ASTM C1136. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and not less than 100 mm (4 inch) butt strips on end joints. Butt strip material shall be same as the jacket. Lap and butt strips may be self-sealing type with factory-applied pressure sensitive adhesive.
- I. Glass Cloth Jacket: Minimum 0.24 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psi) bursting strength, weathertight for outside service. Beach puncture 50 units.
- J. Pipe Covering Protection Saddles: MSS SP-58, Type 39 at all hanger points except where Type 3 pipe clamps are provided.

K. Fire and Smoke Ratings: Assembled insulation systems shall meet flame spread (25) and smoke developed (50) ratings as developed under ASTM C411 and NFPA 255 standards and specifications.

2.18 PIPE AND VALVE FLANGE GASKETS

Non-asbestos, designed for the service conditions. On steam service utilize "Flexitallic" spiral-wound, "Lamons Grafoil Grade GHR", "Lamons Spira-wound", "Garlock ST-706", or equal.

2.19 BURIED UTILITY WARNING TAPE

Tape shall be 0.1 mm (0.004 inch) thick, 150 mm (6 inches) wide, yellow polyethylene with a ferrous metallic core, acid and alkali-resistant and shall have a minimum strength of 12,000 kPa (1750 psi) lengthwise and 10,300 kPa (1500 psi) crosswise with an elongation factor of 350 percent. Provide bold black letters on the tape identifying the type of system. Tape color and lettering shall be unaffected by moisture and other substances contained in the backfill material.

PART 3 - EXECUTION

3.1 GENERAL

- A. Connecting to Existing Work: Connect new work to existing work in a neat and workmanlike manner. Where an existing structure must be cut or existing utilities interfere, such obstruction shall be bypassed, removed, replaced or relocated, patched and repaired. Work disturbed or damaged shall be replaced to its prior condition, as required by Section 01 00 00, GENERAL REQUIREMENTS. Piping connections shall be made only in manholes, tunnels or buildings.
- B. Coordination: Coordinate the location of all items of equipment and work of all trades. Maintain operability and maintainability of the equipment and systems. The contractor at his cost shall perform any relocation of equipment or systems to comply with the requirement of operability and maintainability.
- C. Excavation, trenching, shoring, sheathing, bracing, and backfilling shall conform to Section 31 20 00, EARTH MOVING.
- D. Grading: Unless otherwise shown on drawings, steam lines shall be graded downward not less than 50 mm in 12 meters (two inches in 40 feet) in direction of the flow. Provide eccentric reducing fittings on steam mains and branches, (except on vertical piping). Install said fittings to maintain continuity of grade in bottom of pipeline. Provide risers with drip pockets and steam traps on steam lines where space restrictions prevent continuous grading. All steam traps must be located in manholes or tunnels.

3.2 DEMOLITION

- A. Perform work in accordance with requirements for phasing.
- B. Completely remove all pipe, valves, fittings, insulation, and all hangers including the connection to the structure and any fastenings.
- C. Seal all openings in manhole or building walls after removal of piping.
- D. All material and equipment removed shall become the property of the Contractor and shall be removed from Government property within one week and shall not be stored in operating areas.
- E. All flame cutting shall be performed with adequate fire protection facilities available as required by safety codes and COTR.
- F. Asbestos Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT or Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT.

3.3 PIPING JOINTS AND FITTINGS

- A. Welded Joints:
 - 1. Branch connections shall be made with either welding tees or welding outlet fittings. Welding outlet fittings shall be forged, integrally reinforced to provide 100 percent pipe strength, beveled for full penetration welding and funneled at inlet for full fluid flow.
 - 2. Clean pipe and fittings before welding and installation in system.
- B. Threaded Joints:
 - 1. Pipe threads shall be cut to give proper engagement in threaded fittings. Threaded pipe shall have clean-cut threads; dull or damaged pipe dies shall not be used.
 - 2. Clean pipe and fittings before installation and ream pipe after cutting threads. Joints shall be made with oil and graphite pipe joint compound applied to male threads only.
- C. Fittings: All pipe intersections and all changes in direction shall be made with factory-built-reinforced fittings. Field-fabricated fittings and miters are not permitted.
- D. Flanged Joints: Gaskets and bolting shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains shall be evenly applied without overstress of bolts. Gaskets shall cover entire area of mating faces of flanges.

3.4 CLEANING OF PIPING

Clean pipe and fittings inside and outside before and after assembly. Remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, equipment or fittings.

3.5 WELDING

- A. The Contractor is entirely responsible for the quality of the welding and shall:
1. Conduct tests of the welding procedures used by his organization, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and also determine that the welding operators have the ability to make sound welds under standard conditions.
 2. Comply with ASME B31.1 and AWS B2.1.
 3. Perform all welding operations required for construction and installation of the heat-distribution system.
- B. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1 and AWS B2.1, and also as outlined below.
- C. Examining Welder: Examine each welder at job site, in the presence of the Contracting Officer's Technical Representative (COTR), to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be:
1. Allowed to weld only in the position in which he has qualified.
 2. Required to identify his welds with his specific code marking signifying his name and number assigned.
- D. Examination Results: Provide the COTR with a list of names and corresponding code markings. Retest welders that fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.
- E. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.
- F. Alignment: Utilize split welding rings or approved alternate method for field joints on all carrier pipes above 50 mm (two inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe. Make field joints 50 mm (two inches) and smaller with welding sockets.
- G. Erection: Piping shall not be split, bent, flattened, or otherwise damaged either before, during, or after installation. Where the pipe temperature falls to 0 °C (32 °F) or lower, the pipe shall be heated to approximately 38 °C (100 °F) for a distance of 300 mm (one foot) on each side of the

weld before welding, and the weld shall be finished before the pipe cools to 0 °C (32 °F).

- H. Defective Welds: Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds must be requalified.
- I. Electrodes: Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.
- J. Radiographic Testing: An approved independent testing firm regularly engaged in radiographic testing shall perform radiographic examination of all field welds in the carrier piping of direct-buried systems and concrete trench systems, in manholes and in walk-through tunnels, in accordance with ASME B31.1. Furnish a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project, prior to installing conduit field joints, trench covers, backfilling and hydrostatic testing. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. The COTR reserves the right to review all inspection records, and if any welds inspected are found unacceptable they shall be removed, rewelded, and radiographically reexamined at no cost to the Government.

3.6 DRAIN VALVES AND VENT VALVES

Provide 40 mm (1-1/2") minimum pipe size drain valves on condensate return carrier pipes at all low points in manholes. Provide 25 mm (1") minimum air vent valves in manholes at all high points in condensate return carrier piping.

3.7 PIPE SUPPORT INSTALLATION (IN TUNNELS, MANHOLES)

- A. Coordinate support locations with structure prior to erection of piping. Arrangement of supports shall facilitate operating, servicing and removal of valves, strainers, and piping specialties. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site during construction.
- B. Upper Attachments to Structure:
 - 1. New Reinforced Concrete Construction: Concrete inserts.
 - 2. Existing Reinforced Concrete Construction: Upper attachment welded or clamped to steel clip angles (or other construction shown on the drawings) that are expansion-bolted to the concrete. Expansion bolting shall be located so that loads place bolts in shear.

3. Steel Deck and Structural Framing: Upper attachments welded or clamped to structural steel members.
- C. Expansion Fasteners and Power Set Fasteners: In existing concrete construction, expansion fasteners may be used for hanger loads up to one-third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one-fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.
- D. Special Supports:
 1. Secure horizontal pipes where necessary to prevent vibration or excess sway.
 2. Where hangers cannot be adequately secured as specified, make special provisions for hanging and supporting pipe as directed by the COTR.
 3. Do not attach pipe supports, hangers, clamps or anchors to equipment unless specified for that equipment or unless the COTR gives written permission.
- E. Spring Hangers: Locate spring units within 300 mm (one foot) of the pipe attachment, except in locations where spring assemblies interfere with pipe insulation.
- F. Minimum Clearances in Tunnels:
 1. Floor to bottom of pipe support beam: 50 mm (two inches).
 2. Floor to bottom of pipe insulation jacket: 150 mm (six inches).
 3. Wall to side of pipe insulation jacket: 75 mm (three inches).
 4. Ceiling to top of pipe insulation jacket: 25 mm (one inch).

3.8 PAINTING EXPOSED STEEL SURFACES IN MANHOLES AND TUNNELS

- A. Provide surface cleaning and preparation and apply prime coat of rust resistant metal primer. Refer to Section 09 91 00, PAINTING.

3.9 DIRECT-BURIED SYSTEM INSTALLATION

- A. The system manufacturer shall oversee the delivery, storage, installation and testing of the system. All work shall be in strict accordance with the requirements specified herein and with the printed instructions of the manufacturer. Printed instructions must be available at the site prior to delivery of system components. Any changes required to the design and layout of the system due to site conditions must be approved in writing by the system designer and the COTR. All branch piping connections, valves and drip traps must be located within manholes.
- B. Excavation, Trenching, and Backfilling: Perform all excavation, trenching, and backfilling as required by the system manufacturer's design and as specified in Section 31 20 00, EARTH MOVING. Beach sand or any sand with

large amounts of chlorides is not permitted. Place system on a 300 mm (12 inch) thick sand bed and backfill on all sides with 150 mm (6 inch) thick sand as measured from outside the casing. Foundation for system must be firm and stable. Foundation and backfill must be free from rocks or substances that could damage the system coating. Concrete anchor and thrust blocks must be installed in undisturbed earth. Backfilling must not commence until elevations have been surveyed and accepted and system has been satisfactorily pressure tested including hydrostatic testing of carrier pipes and air testing of casings.

C. Representative of System Manufacturer: This shall be a person who regularly performs the duties listed below, is certified in writing by the system manufacturer to be technically qualified and experienced in the installation of the system, and shall be authorized by the manufacturer to make and sign the daily reports specified herein. The representative shall be present at the job site when the following types of work are being performed:

1. Inspection and unloading of material delivered to site.
2. Inspection of trench prior to commencing installation of system.
3. Inspection of concrete anchors and thrust blocks.
4. Cold springing.
5. Hydrostatic test of all service lines.
6. Field joint closure work.
7. Air test of conduit.
8. Repair of any coatings.
9. Holiday test of conduit coating.
10. Installation of cathodic protection system.
11. Initial backfill up to 250 mm (10 inches) above the top of the casing.
12. The slope of the system. Elevation readings shall be witnessed and recorded.
13. Testing of cathodic protection system.
14. Operational tests.

D. Reports to Contracting Officer:

1. Obtain a written report prepared daily and signed by the representative of the system manufacturer. Present the original report to the COTR on the same day it is prepared, and forward one copy to the manufacturer's main office.
2. The report shall state whether or not the condition and quality of the materials used and the delivery, storage, installation and testing of the system are in accordance with the plans, specifications, and manufacturer's printed instructions and is satisfactory in all

respects. When any work connected with the installation is unsatisfactory, the report shall state what corrective action has been taken or shall contain the system manufacturer's recommendations for corrective action. The report shall identify any conditions that could result in an unsatisfactory installation, including such items as open conduit ends left in the trench overnight and improper manhole entries. The daily reports are to be reviewed, signed and sealed by the Professional Engineer responsible for the system design. Signed and sealed copies of the daily report shall be submitted with the payment requests. All work must stop if daily reports are not furnished and requests for payments shall be denied if the daily reports are not furnished as specified.

3. Upon completion of the work and before final acceptance, deliver to the COTR a notarized Certificate of Compliance signed by principal officers of both the manufacturing and the contracting firm, stating that the installation is satisfactory and in accordance with plans, specifications, and manufacturer's instructions.
 4. The manufacturer shall retain copies of all the daily reports and the Certificate of Compliance for 5 years after final acceptance of the system by the Government.
- E. Protect casing coating from damage during rigging, storage and installation. Protect casing and carrier pipe ends from water intrusion during rigging and installation. Protect casing coatings from ultraviolet light (sunlight).
- F. Defective Material: The Representative shall take prompt action to return to the factory all damaged or defective material and shall order prompt replacement of such material.
- G. Slope of Carrier Pipes: Maintain constant slope as shown or specified. Prior to backfilling over the top of the casing, but after removal of temporary supports, Contractor shall measure and record elevations of top of casing in the trench. Elevations shall be taken at every field joint, 1/3 points along each pipe section, and at tops of elbows. These measurements shall be checked against contract drawings and shall confirm that the conduit system has been installed to the elevations shown on the contract drawings. Slope shall be uniform within 0.1 percent. These measurements shall be recorded by the Contractor, included in the direct buried system manufacturer representative's daily report, and given to the COTR prior to covering the top of the casing with backfill.
- H. Cathodic Protection: Provide cathodic protection for all steel casing systems and all buried exposed metal. Provide dielectric pipe flanges and

unions and isolation devices at all points necessary. Provide test stations at grade on each section of the piping system. Isolation flanges and unions shall be rated for the carrier pipe service temperature and pressure.

- I. Cleaning of Piping: Remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, or fittings.
- J. Field Tests: Refer to Article, TESTS.
- K. Wet Insulation: Sections of system that have been fully or partially submerged in water must be replaced. Moisture content of insulation during installation shall not exceed five percent by weight.
- L. Vents and Drains on Ends of DDT Systems: At each casing termination (end plate) in buildings and manholes, plug the casing drain openings with brass plugs and extend one inch pipe size ASTM A53 galvanized vent pipes from the casing vents through the tops of the manholes or one foot above the conduit in buildings. Terminate the outside vents in 180-degree bends.
- M. Buried Utility Warning Tape: Install tape 300 mm (12 inches) below grade above the piping system.

3.10 BALL JOINT INSTALLATION

Location, spacing and cold set shall conform to layout drawings approved by manufacturer of ball joints. Representative of manufacturer shall visit site and verify that installation is proper. Locate to allow access to all packing injection devices, when provided.

3.11 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments that will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Clean all sliding surfaces, add packing as necessary, remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible manhole or in walk-through tunnel. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

3.12 INSTALLATION - SAFETY VALVES

- A. Location: Valves must be upright and oriented so that lifting levers are accessible from nearest walkway.
- B. Vent System: Instead of drip pan ells, provide special flexible connector on each safety valve that is designed to avoid blow-back of steam into the tunnel or manhole. Provide slip joint arranged to prevent vent line from imposing any strain on safety valve and to prevent moisture accumulation in safety valve. Support vent line from above. Provide drain line to nearest floor drain from flexible connector. Provide separate vent line from each safety valve to atmosphere unless otherwise shown. Piping weight on safety valve outlet shall not exceed that allowed by valve manufacturer.
- C. Accessibility: Provide union or flanged connection at safety valve outlet to allow removal of safety valves without disassembling vents.

3.13 INSTALLATION - PRESSURE GAGES

Locate at inlet and outlet of each pressure reducing station, on each pump discharge and after main stop valves (gate and butterfly valves) on steam distribution lines. Orient gages so that dials are upright and visible from nearest walkway and from operating point of main steam stop valves. Provide gage cock. Provide syphon on steam service. Provide liquid - filled gages on pump discharge.

3.14 INSTALLATION - THERMOMETERS

Orient thermometers so that scales are upright and visible from nearest walkway. Locate wells in flow stream.

3.15 INSTALLATION - VALVES

- A. Do not locate valve stems below the horizontal centerline of the pipe.
- B. Locate valves to permit access for operation, maintenance, and replacement.
- C. Provide 19 mm (3/4 inch) globe-valved warm-up bypasses at all steam gate and butterfly valves 80 mm (3 inch) pipe size and larger.
- D. Provide 19 mm (3/4 inch) gate or ball-valved drains at each side of steam gate and butterfly valves where condensate could collect, due to the slope of the pipeline, when the main valve is shut.

3.16 THERMAL INSULATION

- A. For piping in pre-engineered direct-buried systems refer to Part 2 of this specification.
- B. Steam, condensate and drip return piping, other than in pre-engineered direct buried systems, shall be insulated as follows:

1. Piping in concrete trenches and manholes shall be insulated with calcium silicate, fiberglass, or cellular glass pipe insulation, glass cloth or aluminum jacket.
2. Exposed piping in walk-through tunnels shall be insulated with calcium silicate, fiberglass, or cellular glass pipe insulation, all service jacket. Condensate return piping may be insulated with rigid cellular phenolic, all service jacket.
3. Piping in manholes shall be insulated with calcium silicate or cellular glass pipe insulation, glass cloth or aluminum jacket.
4. Minimum Insulation Thickness: Insulation thicknesses given in Table 5 and 6 are manufacturer's nominal thickness.

TABLE 5 Minimum Pipe Insulation Thickness mm (inches) For Steam 110 to 1724 kPa (16 to 250 psi) gage				
Nominal Pipe Diameter mm (inches)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp	Foamglas
25 (1)	50 (2)	63 (2 1/2)	100 (4)	110 (4 1/2)
40 (1 1/2)	50 (2)	63 (2 1/2)	100 (4)	110 (4 1/2)
50 (2)	63 (2 1/2)	85 (3 1/2)	110 (4 1/2)	125 (5)
65 (2 1/2)	63 (2 1/2)	85 (3 1/2)	110 (4 1/2)	125 (5)
80 (3)	75 (3)	100 (4)	125 (5)	150 (6)
100 (4)	75 (3)	100 (4)	125 (5)	150 (6)
125 (5)	75 (3)	100 (4)	125 (5)	150 (6)
150 (6)	85 (3 1/2)	110 (4 1/2)	135 (5 1/2)	150 (6)
200 (8)	85 (3 1/2)	110 (4 1/2)	135 (5 1/2)	150 (6)
250 (10)	100 (4)	125 (5)	150 (6)	165 (6 1/2)
300 (12)	100 (4)	125 (5)	150 (6)	165 (6 1/2)
350 (14)	100 (4)	125 (5)	150 (6)	165 (6 1/2)
400 (16)	100 (4)	125 (5)	150 (6)	165 (6 1/2)
450 (18)	100 (4)	125 (5)	150 (6)	165 (6 1/2)

TABLE 6 Minimum Pipe Insulation Thickness mm, (inches) For Steam less than 110 kPa (16 psi) gage, Condensate Return				
Nominal Pipe Diameter mm (inches)	MPT-PC MPT-PF	Delta	Foamglas Thermo-12 Super Caltemp	Insul-phen
25 (1) and under	35 (1 1/2)	50 (2)	75 (3)	25 (1)
40 (1 1/2)	35 (1 1/2)	50 (2)	75 (3)	25 (1)

TABLE 6 Minimum Pipe Insulation Thickness mm, (inches) For Steam less than 110 kPa (16 psi) gage, Condensate Return				
Nominal Pipe Diameter mm (inches)	MPT-PC MPT-PF	Delta	Foamglas Thermo-12 Super Caltemp	Insul-phen
50 (2)	35 (1 1/2)	50 (2)	75 (3)	25 (1)
65 (2 1/2)	35 (1 1/2)	50 (2)	75 (3)	25 (1)
80 (3)	50 (2)	63 (2 1/2)	85 (3 1/2)	25 (1)
100 (4)	50 (2)	63 (2 1/2)	85 (3 1/2)	38 (1 1/2)
125 (5)	50 (2)	63 (2 1/2)	85 (3 1/2)	38 (1 1/2)
150 (6)	63 (2 1/2)	76 (3)	110 (4 1/2)	38 (1 1/2)
200 (8)	63 (2 1/2)	76 (3)	110 (4 1/2)	38 (1 1/2)

Insulation listed has passed a boiling test:

Delta is available from Rockwool Manufacturing Co., Leeds, AL.

Foamglass is available from Pittsburgh Corning Corp., Pittsburgh, PA.

MPT is available from Mineral Products of Texas, Houston, TX.

Thermo-12 and Super Caltemp are available from Johns-Manville, Denver, CO.

Insul-phen is available from Resolco International Div.

www.resolco.com

5. Parts Not Insulated:

Threaded valves

Steam traps

Check valves

Unions

Threaded strainers

Strainer basket removal cover and bolting

Dielectric flanges and unions

Expansion joints

Flexible connectors

Ball joints except piping between joints

6. Installation:

a. Complete all pressure tests before installing insulation.

b. All insulation material shall be new, clean, dry and stored in a clean dry environment; jacketing materials shall be clean and unmarred; store adhesives in original containers. Materials shall not have exceeded the predicted shelf life as set by manufacturer.

- c. Identify all materials incorporated in the job on manufacturers container by name, type and description.
- d. Apply materials on clean, dry surfaces from which all dirt, loose scale, construction debris has been removed by wire brushing.
- e. The installation shall be neat, thermally and structurally tight without sag, neatly finished at all hanger or other penetrations and shall provide a smooth finished surface primed as required to receive specified painting.
- f. Do not use scrap insulation. Repair any work damaged by welding, burning, compressing due to concentrated construction loads.
- g. Apply pipe covering protection saddles (MSS SP-58, Type 39) at all hanger points. Fill space between saddle and piping with high density insulation, thoroughly packed. Terminate jacket clear of saddle bearing area.
- h. Insulation and jacket shall terminate hard and tight at all anchor points.
- i. Insulation termination at piping facilities not to be insulated shall stop short, and be finished with 45 degree chamfered section of insulating and finishing cement, and covered with jacket.
- j. Flanged fittings and valves shall be insulated with sections of pipe insulation cut, fitted and arranged neatly, and firmly wired in place. Insulating cement shall fill all cracks, voids and outer surface for covering with glass cloth. Insulation of valve bonnet shall terminate on valve side of bonnet flange to permit valve repair.
- k. On calcium silicate, cellular glass and rigid cellular phenolic insulated piping systems, fittings shall be insulated with field or factory-shaped sections of insulation, finished with specified insulating and finishing cements and covered with jacket or PVC premolded cover. On sizes 50 mm (two inches) and smaller it is permissible to apply insulating and finishing cements, and cover with jacket or PVC premolded cover.
- l. Fiberglass insulated piping systems fittings over 50 mm (two inch) size shall be insulated with specified molded pipe fitting insulation or compressed blanket, finished with specified insulating and finishing cements and covered with specified PVC fitting jacket. On sizes 50 mm (two inches) and under apply insulating and finishing cements and cover with PVC fitting jacket.

- m. Apply glass cloth jacket using an approved adhesive. Glass cloth shall be smooth, tight and neatly finished at all edges; prime cloth to receive paint specified in Section 09 91 00, PAINTING.

3.17 BURIED UTILITY WARNING TAPE

Bury directly above direct-buried system approximately 300 mm (12 inches) below grade.

3.18 IDENTIFICATION SIGNS

- A. Valve Identification: Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16 inch) high, on all isolating valves on steam and condensate return system, identifying building or area served. Attach to the valves with corrosion-resistant chains.
- B. Pipe Identification: Label service of all pipes in manholes and walk-thru tunnels. Refer to Section 09 91 00, PAINTING.

3.19 TESTS

- A. Demonstrate leak-tightness of all piping systems by performing hydrostatic and operational tests. All labor, material and test instruments must be furnished by the Contractor. All instruments must be approved by the COTR.
- B. Pressure test direct-buried systems in conformance with requirements stated in this specification and in printed instructions for the system supplied. Tests must include carrier piping and casing.
- C. Holiday testing of direct-buried system steel casings: Test entire surface of casings for faults in coating after installation in trench prior to backfilling. Use test method and voltage recommended by coating manufacturer. Repair any holidays found and retest. System shall not be backfilled until all holidays are eliminated.
- D. Radiographic testing of carrier pipe welds: Refer to Article, WELDING, in Part 3 of this specification.
- E. Before conducting steam system operating test, remove steam trap elements or use bypass connections around traps; then flush lines with high pressure water until discharge shows no foreign matter to the satisfaction of COTR.
- F. Hydrostatic and Operational Tests of Carrier Piping: Steam and condensate carrier piping shall be tested hydrostatically before insulation is applied at field joints and shall be proved tight at a pressure 1-1/2 times distribution supply pressure for a period not less than 2 hours with no pressure decay.
 - 1. Test piping located in concrete trenches prior to installing trench covers. Test direct-buried systems prior to backfilling.
 - 2. Remove or isolate any elements of the system such as expansion joints, which are not designed for the test pressure.

3. Prior to acceptance of installation, Contractor shall subject system to operating tests as may be required by COTR to demonstrate satisfactory functional and operating efficiency. These operating tests shall cover a period of not less than six hours for each portion of system tested. Conduct tests at times as the COTR may direct.
 4. Provide calibrated instruments, equipment, facilities and labor, at no additional cost to the Government. Test gage shall read in increments not exceeding 1 kPa (0.1 psi).
 5. Repeat tests when failures occur.
 6. After completion of satisfactory test, replace all elements that have been removed prior to testing.
- G. Pneumatic Testing of DDT System Casings:
1. Perform test on all sections of the system before field-coating the field joints and before back-filling.
 2. Test shall be with compressed air at 100 kPa (15 psi) for 24 hours with pressure source disconnected and with no decay in pressure. Corrections to the readings are permissible to compensate for significant ambient temperature changes during the test period.
 3. Pressure shall be measured with a gage with reading increments of 1 kPa (0.1 psi).
 4. Each casing field joint shall be tested for leaks by means of soap solution or equivalent.
- H. NACE-accredited corrosion specialist shall test cathodic protection systems and demonstrate proper operation and protection in accordance with the recommendations and criteria in NACE RP0169 and in Section 26 42 00, CATHODIC PROTECTION.
- I. Deficiencies discovered shall be corrected at the Contractor's expense, to satisfaction of COTR. Major deficiencies or failure to correct deficiencies, to the satisfaction of the COTR, may be considered cause for rejecting the entire installation.

- - - END - - -

SECTION 347526**HELICOPTER LANDING SYSTEM****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Pre-engineered aluminum helicopter landing system.
- B. Supplementary items necessary to complete work requirements for their installation.

1.2 RELATED WORK

- A. Section 05 21 00 - Structural Steel Framing: Building columns and beams.
- B. Sections of Division 22: Indoor hot water piping to/from snow melting equipment.
- C. Sections of Division 26: Conduit and wiring for light fixtures including perimeter lights and snow melting equipment.
- D. Sections of Division 26. Lightning protection.

1.3 REFERENCES

- A. ASTM A 123 - ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM B 221 - ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- C. AWS D1.1 - Structural Welding Code - Steel.
- D. AWS D1.4 - Structural Welding Code - Reinforcing Steel.
- E. NFPA 418 - Standard for Heliports.
- F. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids.

1.4 SYSTEM DESCRIPTION

- A. General Description: Heliport of size and configuration indicated on Drawings consisting of hot dipped galvanized structural steel framing supporting a pre-engineered and prefabricated aluminum helicopter landing surface with connecting ramp/walkway, surrounded by a safety net, and emergency exit stairs with guardrails. Structure shall be equipped with heliport lighting, fuel/water separator, foam fire suppression, and hydronic snow melting system.

1.5 PERFORMANCE REQUIREMENTS

- A. Design helicopter landing system in accordance with applicable code to accommodate dynamic loading requirements of a 22,000 lb gross weight helicopter, but not less than a uniform live load of 100 psf, and the following:
 - 1. Uniform wind uplift of 24 psf.

2. Uniform load of 50 lb/lin ft, applied to any direction to top of guard rail, hand rail and concentrated load of 200 pounds applied at any point in any direction to rail and posts as required.
3. Concentrated load of 250 pounds applied over any one square foot of safety netting.
4. Uniform and concentrated loads need not be considered acting simultaneously.

1.6 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications to evidence compliance with these specifications.
- B. Shop Drawings: Prior to fabrication, submit complete fabrication details and erection drawings.
- C. Calculations: When requested submit design calculations and erection drawings, bearing the seal of a Professional Structural Engineer registered in the Commonwealth of Pennsylvania.
- D. Welders' Certificates: Submit evidence of certification in the past 12 months in accordance with AWS D1.1 and AWS D1.4.
- E. Manufacturer's instructions: Submit cleaning and priming instructions for helicopter landing surface.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualification: Company capable of designing, fabricating and installing helicopter landing systems as indicated on Drawings and specified herein.
- B. Welders Qualification: Certified in the past 12 months by AWS (American Welding Society).
- C. Field Measurements: Take field measurements to locate building columns, beams and other attachment points. Coordinate requirements for on-site support required for erection of items supplied. Show dimensions on shop drawings.

1.8 WARRANTY

- A. Manufacturer Warranty: Provide two year manufacturer warranty against fading, flaking, cracking or other deterioration of painted markings. Include provision for repainting defective markings.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Design is based on components designed and supplied by Heliport Systems Inc., Morristown, NJ; Telephone (800) 540-0011. Facsimile (973) 540-0131. Web Site www.heliport.com. or equivalent.

2.2 HELICOPTER LANDING SYSTEM

- A. Structural Steel Support Framing: Steel girders and beams, hot dip galvanized, designed to support helicopter landing surface.
- B. Helicopter Landing Surface: Heliport Systems™ Aluminum Helideck System. Interlocking deck extrusions minimum 8 inch (200 mm) in width with extruded tube inside for snowmelt glycol solution.
- C. Material: ASTM B 221 extruded aluminum alloy, section modulus minimum 14.03 cu in.
 - 1. Surface Texture: Inherent non-skid helicopter landing and pedestrian walking surfaces without use of coatings of any kind.
 - 2. Deck Sealant: Jet fuel resistant type capable of continuous water immersion as recommended by manufacturer.
- D. Tie-downs: Provide tie-downs of the following types.
 - 1. Four helicopter tie-downs such that tops of tie-downs are completely flush with top of helicopter landing surface, or Relocatable tie downs that latch onto the deck in any location, capable of accommodating any make and model of helicopter being tied down anywhere on helicopter landing surface, facing in any direction.
- E. Walkway Ramp: ASTM B-221 aluminum alloy with inherent non-skid walking surface without use of coatings.
 - 1. Capable of supporting load of 100 lb/sq ft.
 - 2. Extruded interior glycol channel for snowmelt purposes.
- F. Drainage Gutter: Manufacturer's standard prefinished aluminum gutter of width and depth necessary to drain one in 50 year storm.
- G. Safety Net: 9 gage woven wire mesh with openings 1-1/4 inch (31 mm) square in size, hot dip galvanized, for attachment to aluminum angle support frame bearing on outriggers.
 - 1. Fabricate to dimensions indicated on Drawings.
 - 2. Top of safety net not to project above helicopter landing surface.
- H. Fuel/Water Separator: Gravity flow type. Provide where indicated on Drawings, including structural supports necessary. Pipe water only outlet to nearest roof drain capable of handling flow.
 - 1. Water Flow Rate: Minimum 200 GPM.
 - 2. Fuel Flow Rate: 30 GPM.
 - 3. Separator: Comply with Factory Mutual requirements specifically for heliports, and:
 - a. Material: Type 304 stainless steel with 330 gal (1249 L).

- b. Equip with 330 gallon (1249 L) mild steel UL 142 fuel containment tank, mild steel, painted black.
 - c. Insulate and heat Separator Unit for freeze protection; furnish with a fuel alarm switch and bell.
- 4. Product: Model H-200 Heliport Fuel/Water Separator.
- I. Lighting Fixtures: Comply with FAA Specification L-807.
 - 1. Lighted Wind Cone: Internally lighted type, with integral electrical slip ring and weatherproof stainless steel, greaseless bearings.
 - a. Frame: 18 inch (455 mm) diameter by 30 inch (765 mm) horizontal with windsock.
 - b. Windsock: Nylon material, orange in color; 96 inch (2438 mm) in length, 18 inch (457 mm) diameter at one end and 9 inch (228 mm) diameter at other end.
 - 2. Pole: Aluminum, brushed finish, hinged at base to permit changing of lamp and windsock; equip base with electrical junction box.
 - 3. Lamps: PAR 38, 120 volts AC, 90 to 120 watts.
 - 4. Fixture: Model ILWC-18.
- J. Perimeter Lights: Omnidirectional type with FAA Specification L-861 lens, green in color, with 67 watt 8000 hour traffic signal lamp.
 - 1. Base: Cast aluminum type with junction box to permit direct connection of conduit without separate junction box required.
 - 2. Fixture: Model HPL.
- K. Foam Fire Suppression System: Provide permanent, fixed foam fire suppression complying with NFPA 418 for a Category H-2 Rooftop Heliport.
 - 1. Only permanent, fixed storage connected to the building's fire protection water standpipe system shall be used. Foam shall be dispensed from an oscillating monitor/nozzle.
 - 2. Portable foam fire extinguishers for NFPA 418 Category H-1 heliport are not permitted.
- L. Snow Melting System: Provide for helicopter landing surface and walkway/ramp. Hydronic type in which a solution of 50% propylene glycol/50% water is pumped through the aluminum decking, back to heat exchanger for reheating (closed loop), with the heat source bldg. hot water (180 deg F) at 175 GPM rate of flow into the heat exchanger.
 - 1. Heliport Vendor shall provide pre-engineered, pre-assembled Heat Transfer Unit on a skid consisting of heat exchanger, PID control

- valve, circulation pump, expansion tank, air separator, pressure/temperature gauges, Control panel with Hand-Off-Auto switch and BAS contacts for remote On/Off operation. Unit shall be set in an indoor space near the heliport.
2. Heliport Vendor shall provide outdoor Snow Sensor to automatically turn the system On at start of snowfall, Off 90 minutes after snowfall stops.
 3. Heliport Vendor shall provide all outdoor/above the roof conveyance of glycol/water solution to/from the heliport landing surface and walkway/ramp.
 4. Source of heat for the unit shall be bldg. hot water (180 deg F at 175 GPM) shall be provided by Division 15 and electric circuit for the unit shall be 460 VAC 3 Phase 20 amp shall be provided by Division 16. 3" black iron cut groove pipe glycol solution supply/return lines from the unit to the outside the building shall be provided by Division 15.

2.3 PAINTED MARKINGS

- A. Provide painted helicopter landing surface markings of colors indicated on Drawings.
- B. Comply with Federal Aviation Administration (FAA) requirements.
- C. Applied marking paint shall not reduce coefficient of static friction of landing and walking surface.
- D. Markings: Apply primer suitable for aluminum and two finish coats of traffic marking paint. Apply per manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine and verify that roof area below heliport system has no equipment, defects or errors that may result in poor or potentially defective application or cause latent defects in workmanship.
- B. Starting installation shall imply acceptance of surfaces.

3.2 PREPARATION

- A. Field Measurement/Verifications: Field measure and verify dimensions as required.
- B. Protection of Adjacent Areas or Surfaces: Protect adjacent areas or surfaces from damage as result of Work of this Section.

3.3 ERECTION

- A. Erect in accordance with manufacturer's latest published requirements, instructions, specifications, and details and reviewed shop drawings.

- B. Set, align and anchor helicopter landing system members in method approved by the manufacturer. Provide temporary shoring and bracing as required. Set deck members to slope indicated such that entire helicopter landing surface drains to gutter system. Provide elevations and alignment as required.
- C. Helicopter landing system manufacturer is responsible for supplying, delivering to the site, and installing components required for a complete and usable installation whether or not indicated on Drawings or specified.
- D. Fasten aluminum helicopter deck and ramp deck to structural steel framing with aluminum stainless steel fasteners; isolate aluminum and steel to prevent galvanic corrosion.
- E. Install light fixtures and perimeter lights in locations indicated on Drawings.
- F. Clean helicopter landing surface in accordance with manufacturer's instructions prior to applying painted markings.

- - -END OF SECTION- - -